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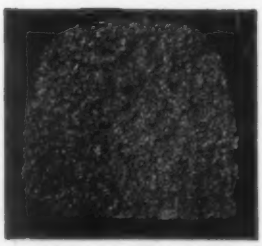
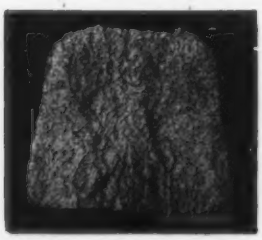
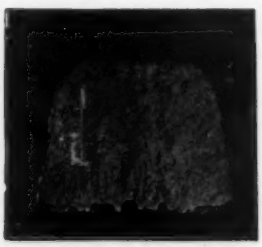

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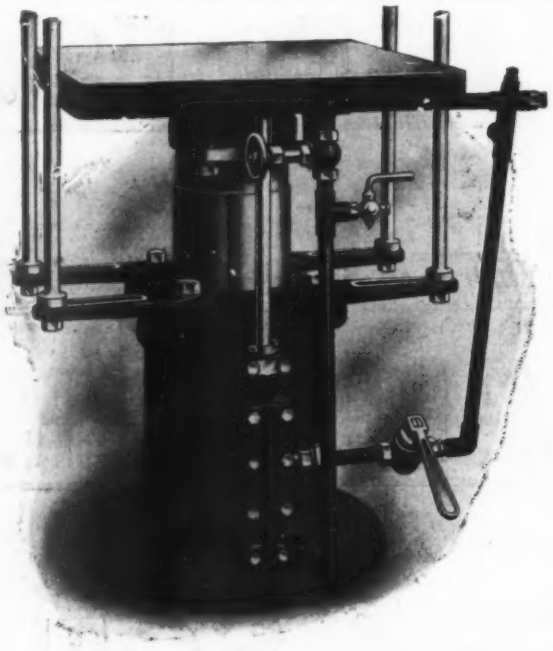

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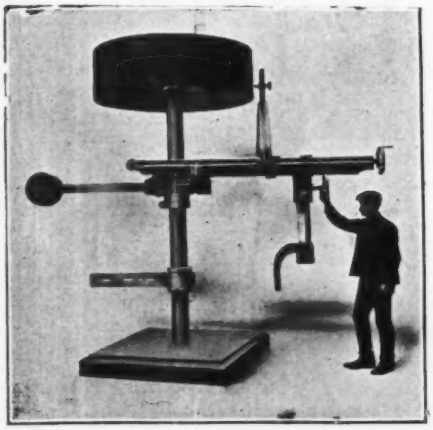

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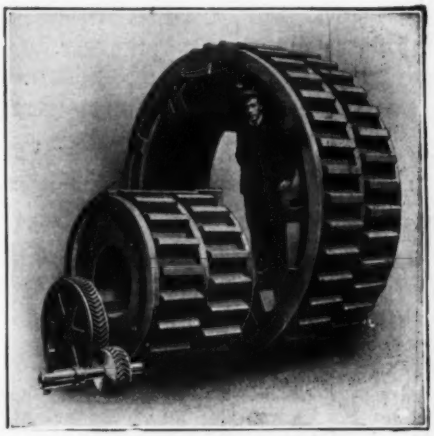

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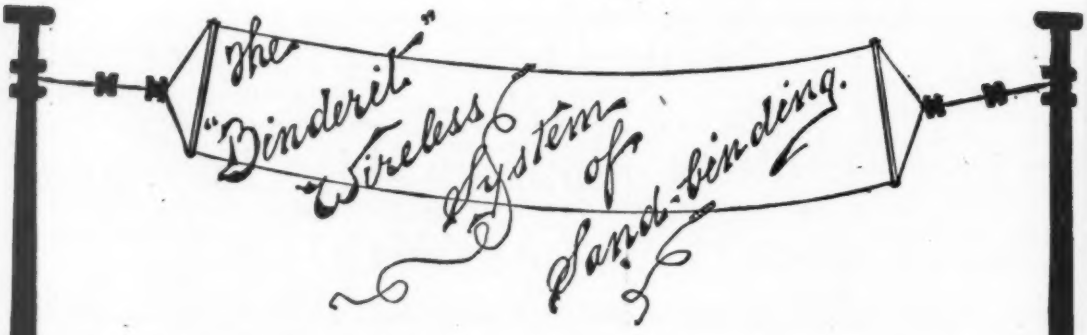

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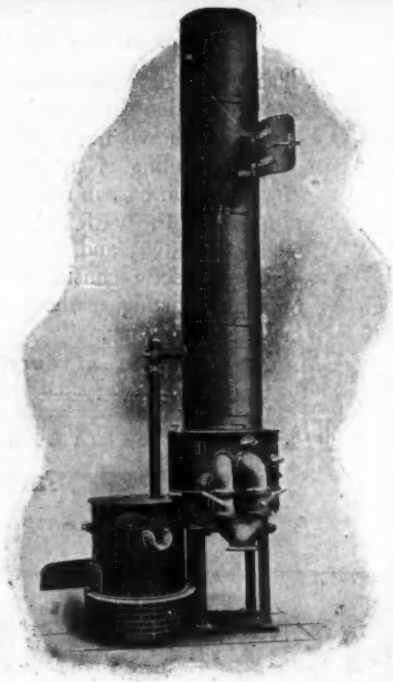

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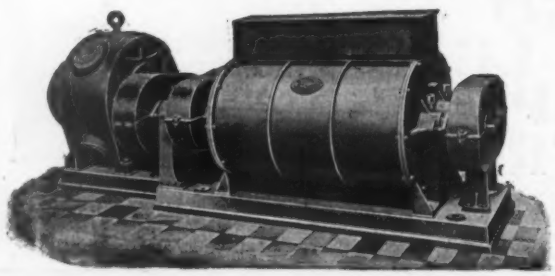

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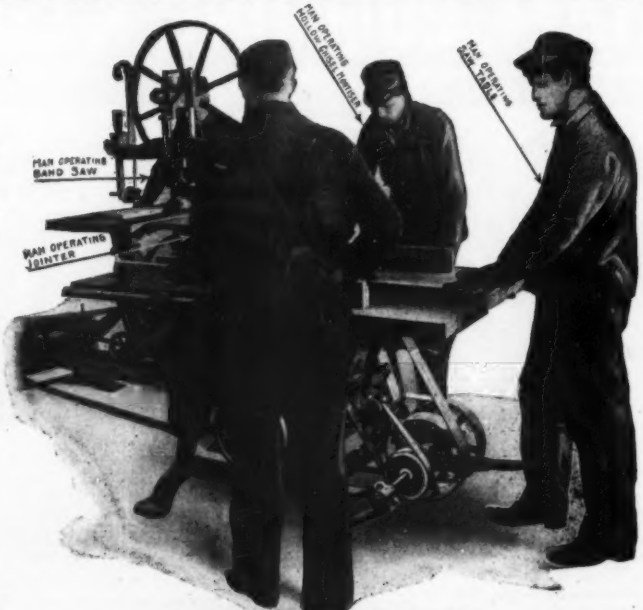

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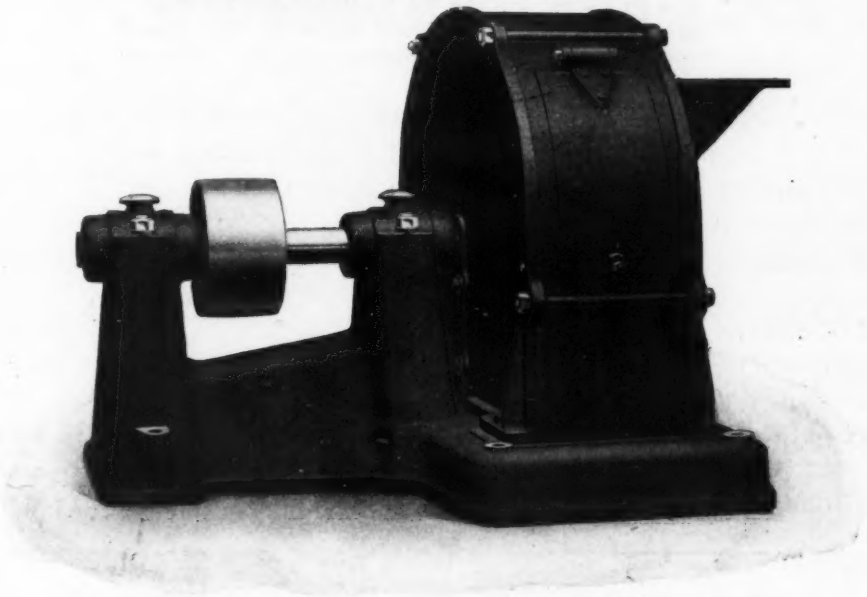

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162

The Foundry Trade Journal

AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

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All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

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165, Strand, London, W.C.

WE INVITE PRACTICAL ARTICLES ON THE TRADE IN ALL ITS BRANCHES, WHICH WILL BE PAID FOR. MSS. SHOULD BE WRITTEN ON ONE SIDE OF THE PAPER ONLY.

BRITISH FOUNDRYMEN'S ASSOCIATION.
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Manchester: A. Harrison, 705, Manchester Road, Castleton.
Birmingham: C. Grindlay, 39, Copsley Hill, Erdington, Birmingham.
Sheffield and District: J. Dickinson, 157, Abbeyfield Road, Pitsmoor, Sheffield.
Scottish: W. O. Gray, Royal Technical College, Glasgow.
London: Alexander Hayes, 165, Strand, London, W.C.
Halifax: J. G. Robinson, 17, Gibraltar Road, Halifax.
Newcastle-on-Tyne: H. A. J. Rang, Cleveland Road, North Shields.
Leicester and District: S. H. Russell, Bath Lane, Leicester.

Contents.

	Page
Notes and Comments	295
British Foundrymen's Association—Annual Meeting in London	297
A Progressive Australian Foundry	305
The Cooling of Metals	307
Casting Gunmetal in Chills	309
Sound Ingots for Shell Steel	310
Notes on Copper Alloys and Brassfounding	315
Core Boxes and Core-Making	321
The Use of Denseners and Heat Treatment of Cast Iron	323
A Journeyman Moulder's Opinion of His Craft	324
The Edgwick Works, Coventry	326
Use of Pulverised Coal	327
Chipchase's Core-Making Machine	328
British Foundrymen's Association—Lancashire Branch	329
Birmingham Branch	331
The Iron and Steel Institute	330
F.T.J. Bookshelf	331
Trade Talk	332
Personal	334
Deaths	335
Parliamentary Notes	336
Applications for Patents	336
New Companies	336
State Control of Workers	338
British Steel Smelters Annual Report	338
Monthly Price Lists	340

NOTES AND COMMENTS.

Sound Steel Ingots.

On another page we publish an illustrated article dealing with a process for producing sound steel ingots and similar castings, which was developed by Sir Robert Hadfield. It is now a year or two since this process came before the metallurgical world, but in the meantime it seems to have been prosecuted with considerable success in Sheffield practice. Before the Iron and Steel Institute in London last month, Sir Robert presented a lengthy Paper on the process as applied to rail steel. The experiment and investigations discussed related to American practice, Dr. G. K. Burgess, of the Bureau of Standards, Washington, being a co-author of the Paper. In introducing the latter Paper, Sir Robert remarked that the origin of the particular research came about as the result of some experiments in which he poured molten copper into the top portion of an ordinary steel ingot about ten minutes after it had been cast. It was then found that the copper penetrated even to the bottom of the ingot, thus showing how important it was to maintain ferro-static pressure by feeding methods for much longer than was ordinarily thought necessary. If that were not done then satisfactory ingots, free from unsoundness, piping and segregation, could not be obtained. It cannot be denied that the waste in steel-making to-day is gigantic; the world's estimated output of steel is about 75,000,000 tons per annum, and probably at least 25 per cent. to 30 per cent. is wasted in the form of scrap and requires to be remelted. Moreover, there is the serious loss from oxidation to be considered; each time the steel is re-melted in the form of scrap there is a certain amount of loss which is never recovered.

The principle of the process in question is quite in keeping with recognised facts in foundry practice. Most moulders know that to keep a feeding head fluid longer than the casting is to get a sounder product, though the cost in scrap metal from very large heads induces a reduction to the minimum permissible for soundness—and below that sometimes—in foundry practice. The use of the feeding rod in iron-foundry work is an attempt to prolong the fluidity of the head or feeding metal. With the general run of castings, of course, the Hadfield process could not be applied in the same way as for an ingot. The latter exhibits a definite and accessible interior shrinkage or "piping" and the metal in the head, so long as it is fluid, can readily supply the requirements of the shrinkage. In most castings this possibility is modified considerably, though the size of head frequently seen in the steel foundry is a testimony to the fact that proper feeding is an understood part of the casting art.

In the course of the discussion on Sir Robert's paper last month, Mr. Benjamin Talbot suggested that the superiority claimed for the process resulted from the refractory top or mould which is used to encase the head. Personally, he said, he was a believer in the brick-lined top, when it was desired to reduce the piping in the ingot, or at any rate to

bring the pipe nearer to the top, and it was to the use of this well-known, old device that he attributed Sir Robert's better results, rather than to the special blow-pipe arrangement which was used in addition. Mr. Talbot referred to certain experiments he had made, using a refractory top to the ingot moulds. The ingots produced tended to support his contention, as the cavities were all in the sink-head portion and the remainder of the ingots perfectly solid. A top-cast ingot with a brick-lined sink-head was perfectly solid below the sink-head, and the analysis was normal just below that. A pair of bottom-cast ingots filled at the same time from the same central runner were also cast. In one case the ingot had the larger end at the base, and in the other case the ingot mould was reversed to permit of its larger end being at the top. The result was that, if anything, the ingot cast with the small end at the top, in the ordinary way, was a better ingot than the one cast with the large end up. The ordinary ingot was normal in its analysis at the base of the brick lining, having 0.38 per cent. carbon and 0.061 per cent. sulphur in the centre of the ingot at that point, whilst the companion ingot at the same point had 0.51 per cent. carbon, and 0.096 per cent. sulphur.

The case of steel ingots is not, of course, strictly analogous to that of castings in sand moulds, since the former are poured into metallic moulds of considerable heat conductivity. A sand or refractory top to such a mould would give a greater difference in the rates of cooling of head and body of metal respectively than would be obtained with a sand head on a sand-casting mould. At the same time the principle is sound, even when applied to sand castings. Whether the Hadfield process is applicable to all sizes of ingots has yet to be seen, for, as pointed out by Mr. Talbot, the time necessary for the completion of the characteristic formation on a large ingot might be so great as to decrease the life of the mould very considerably. It is quite possible that some such consideration may restrict the application of the process, but without question it has technically proved sound.

The New Minister of Education.

The appointment of Mr. Arthur Henderson to the Cabinet rank of Minister of Education is a matter of direct interest to the foundry trade. Mr. Henderson is, we believe, the first actual foundry representative in Parliament, and he is certainly the first to be included in any Cabinet. But apart from that, and, of course, entirely apart from politics, into which it is not the function of this journal to enter, we cannot but welcome the occupation of the office in question by one whose intimate acquaintance with industry and labour ensures a clear insight into the relations between education and industry. It is not probable that much greater activity in educational reform will be initiated before the conclusion of the war, but it must not be forgotten that the consolidation of our industrial position is closely related to the efficiency of our educational methods. It is admittedly difficult at the present time to treat seriously questions which seem related rather to the times of peace than to war conditions, but it is nevertheless important to keep in front of us those reforms which will affect the process of recovery from the terrific shaking which the world's industries have received and which is still proceeding. There are many reforms the necessity for which will become strikingly apparent as soon as public attention can concentrate itself on matters other than war and its exigencies, and among these reforms is the reorganisation of our system of separating elementary education from the civic and industrial activities which it should serve. Our competitive power as a nation is seriously involved in this question, and while it would be out of place to press for immediate attention to the matter, it must not be regarded as something that may take a back place until normal conditions have been totally restored. As we have already stated, an efficient educational system is necessary for the restoration of our industrial stability and progress.

Neglected Pioneers.

Five years ago the metallurgical world was surprised with the news that M. Pierre Martin, the joint inventor of the steel-making process known in this country as the Siemens-Martin open-hearth process, had been discovered living in humble retirement in Central France; and a general movement, participated in by Great Britain, France, Belgium and Germany, was made to acknowledge the service to mankind which had been rendered by the aged inventor and also to financially ease the conditions in which he passed the closing years of his life. Further, at the meeting of the Iron and Steel Institute last month the Bessemer Gold Medal was (by proxy) conferred upon him. A few days later the news arrived that the recipient had passed away. There can be no doubt that the public recognition of his services to iron and steel metallurgy was a pleasure to M. Martin, after the years of disappointment and neglect he had experienced, and we cannot but feel glad that he did not entirely share the fate of so many others whose services have been accepted and utilised with the barest of acknowledgment. Perhaps some day the metallurgical world will wake to a sense of shame at the neglect of those early pioneers whose efforts were the foundation of our present position of advancement, and will make a concerted effort to establish some form of permanent memorial to the honour of their names. The foundry trade alone has a goodly list of neglected pioneers, and while foundry literature occasionally makes reference to the debt we owe, there is little other and certainly no general recognition accorded, whereby the names and work of those men may be handed down from generation to generation. There are, of course, exceptions to this statement, but it would be a service to posterity, and a duty to those who have gone before, to place on record the attainments and services of all who have in the past contributed importantly to the advancement of the foundry trade. Is it too much to hope that we may yet see the movement started?

MELTING CAST-IRON BORINGS.—In the course of a recent discussion on this topic before the Chicago Foundrymen's Club it was stated that the cost of preparing briquettes was the determining factor in that practice. With reasonably low cost, the use of borings was found to be as feasible as any other grade of scrap. At the Deering Works of the International Harvester Company borings have been melted for a number of years, the method being to pack the borings in stove pipes with the bottom closed in, covering the borings with a steel disc, and hammering over the top edge of the pipe so as to seal it up. They found the cost of doing this was about 6s. a ton. At the old Fraser & Chalmers' plant a considerable experience was had in handling borings, and it was the practice there to occasionally make a heat of borings exclusively. It was found that by packing them in boxes, nail kegs, etc., they could be melted down with a loss of about 25 per cent. They were poured into pigs and piled in the yard, just as other stock, and were then analysed and used very satisfactorily on certain classes of work in place of No. 6 charcoal iron. Allowing 16s. 8d. a ton as the market price of cast borings, these pigs cost, when piled up in the yard, 46s. a ton.

British Foundrymen's Association.

Annual Meeting in London.

The annual general meeting of the British Foundrymen's Association was held in the Connaught Rooms, Kingsway, London, on Saturday, June 5. The President, Mr. S. A. Gimson, was in the chair at the commencement of the proceedings.

The SECRETARY having read the minutes of the last annual general meeting, the report and accounts were presented.

REPORT OF COUNCIL.

The Council reported as follows on the progress and work of the Association during the past session:—

Six Council meetings have been held at the following places:—Birmingham (2), Leeds, London, Manchester and Sheffield, and Members have attended from Basford (Stoke), Birmingham, Bolton, Cardiff, Castleton (Lancs.), Derby, Dudley, Dumbarton, East Dereham (Norfolk), Falkirk, Halifax, Horsehay (Shropshire), Leicester, London, Luton, Manchester, Sheffield, Sowerby Bridge, Warrington, and West Bromwich.

MR. W. MAYER (Dumbarton).
(President of the British Foundrymen's Association.)

The Literary Committee will shortly be reviewing papers given before the Branches during the past session, and the awards for the best papers will be published and diplomas given.

The Branches are doing excellent work; many interesting papers have been read and discussed, and visits to various works have been much appreciated by the Members.

A new Branch is in formation, which at present comprises the districts surrounding Leicester, Derby, Nottingham, Rugby, and Loughborough. Many new members have been obtained, and it is hoped that when a full programme of papers can be arranged a strong Branch will be formed.

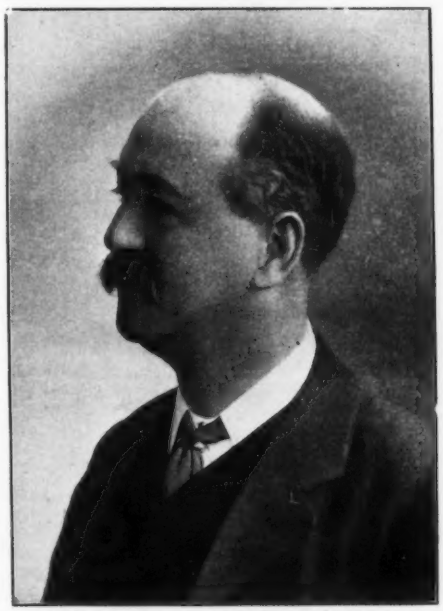
The respective Branches have the following Members attached to them:—

	Members.	Associate members.	Associates.	Total.
Birmingham	12 (20)	77 (67)	55 (53)	144
Halifax	13 (15)	33 (38)	31 (60)	77
Lancashire	37 (33)	95 (88)	33 (31)	165
Leicester	17 (—)	32 (—)	14 (—)	63
London	50 (52)	64 (64)	22 (17)	136
Newcastle	26 (27)	43 (36)	30 (27)	99
Sheffield	35 (34)	74 (70)	21 (16)	130
Scottish	28 (29)	93 (92)	69 (63)	190

Last year's figures are given in brackets.

The total number of Members on the roll of the Association is 1,047, against 974 last year. The members consist of 7 Honorary Life Members, 6 Life Members, 228 Members, 533 Associate Members, and 274 Associates. Twelve Members, 27 Associate Members, and 34 Associates, making a total of 73, have resigned or ceased to become Members, and 23 Members, 74 Associate Members, and 49 Associates, making a total of 146, have been elected.

Nine members of the Council are retiring and are eligible for re-election. According to the new rule, however, there are only five vacancies on the Council. The following have been nominated:—J. E. H. Allbut, W. F. Bagnall, G. Forrester, C. Heggie, H. Jewson, E. P. Page, H. Pemberton, F. Penlington,



MR. SYDNEY A. GIMSON (Leicester).
(Retiring President.)

M. Riddell, J. G. Robinson, J. Simkiss, T. Swinden, J. B. Tattersall.

A preliminary report has been presented to the Council by the Special Committee on Apprentice Training, and is now issued to the Members in pamphlet form.

INCOME AND EXPENDITURE ACCOUNT.

January 1 *to December* 31, 1914

INCOME.

	£	s.	d.
Subscriptions received	302	15	6
Sale of books, &c.	0	14	0
Balance being excess of expenditure over income for the year	32	6	0
	£335	15	6

EXPENDITURE.

	£	s.	d.	£	s.	d.
Postages				22	4	8
Printing and stationery (including printing of proceedings)				108	3	11
Council and finance expenses				22	18	1
Branch expenses, viz.:						
Lancashire	19	1	10			
Sheffield	13	7	4			
Scottish	19	6	9			
Newcastle	13	4	8			
Birmingham	14	12	8			
London	17	19	5			
Halifax	6	4	9			
				103	17	5
Expenses, Annual Meeting				9	7	4
Audit fee				4	4	0
Clerical assistance				10	0	0
Incidental expenses				3	1	7
Grant to Apprentices' Committee				5	0	0
Honorarium to Secretary				42	0	0
Bank charges				0	1	0
Professional charges (Auditors)				4	17	6
				£335	15	6

BALANCE SHEET.

December 31, 1914.

ASSETS.

	£	s.	d.	£	s.	d.
Cash in hands of Secretaries, viz.:—						
Lancashire	0	17	0			
Sheffield	4	13	3½			
Scottish	24	8	10			
Newcastle	5	18	2			
Birmingham	5	11	11			
London	16	19	7			
Halifax	0	15	3			
General Secretary	84	3	8½			
				143	7	9
London City and Midland Bank, Limited				23	12	9
Furniture, fixtures, and fittings	15	0	0			
Add additions	3	13	6			
				18	13	6
				£185	14	0

LIABILITIES.

	£	s.	d.	£	s.	d.
Subscriptions paid in advance				30	19	6
Surplus as at 31st December, 1913	187	0	6			
Less excess of expenditure over income for year ended 31st December, 1914	32	6	0			
				154	14	6
				£185	14	0

NOTE.—There are arrears of subscriptions amounting to £187 19s. 0d. which are not included in these accounts.

We have examined the above Balance Sheet with the books and vouchers of the Association, and find same to be in accordance therewith.

FRANK CREKE, HARCOURT & CO. *Auditors*,
23 Colmore Row, Birmingham.

The PRESIDENT proposed the adoption of the Council's annual report and balance sheet. Considering the extraordinary circumstances of the year which had just concluded, he thought this could be regarded as a satisfactory report. But for these special circumstances they would not have been quite satisfied with the result. Greater progress would have been expected. It was to be regretted that they had to forego the usual three days' Conference, which everybody looked forward to and had enjoyed so much in the past. Everyone, however, was so preoccupied with far more important things that this year the Council decided it would not be wise to attempt a three days' conference. Hence they had called simply an annual meeting, and although it might be regretted that there was not a larger attendance, those who were present would be able satisfactorily to carry out the business required.

The report did show progress, but the balance sheet in several respects was rather unsatisfactory. The main item which was unsatisfactory was the receipts, which were something like £150 to £160 less than in the previous year. For this he thought there were two main reasons. One was that the Council had gone very strictly through the membership lists and had crossed out a considerable number who only joined for a short time, and for a time the membership was lower than it was twelve months ago. The principal reason perhaps for the lowness of the subscriptions received was that there was a large amount not yet collected. The subscriptions in arrear were something like £187 and that was largely due to the fact that the local secretaries, upon whom fell the main burden of collecting the subscriptions, had been so busy in other directions and had had their minds so much on other work that they had not been quite so active as usual in getting in the subscriptions. In looking through the lists, however, it was realised that the greater part of these arrears represented perfectly good subscriptions which would come in. Since the balance sheet had been made out a considerable number had been paid, and in the end he had no doubt things would work out satisfactorily. Recognising that the balance sheet was not quite one which the Council would have liked to put before the members, it had been decided that previous to every meeting the Council held in the future, a meeting of the Finance Committee would be held with the object of trying to work the balance sheet up into a better position, so that they would be closer on to the subscriptions in the future than they had been in the past.

MR. W. F. BAGNALL seconded the adoption of the report and balance sheet.

MR. W. MAYER said the President had explained the position so well that there was nothing more to say. The Council had purged the roll of membership and taken off a number of members who were of no assistance to the Association.

In reply to a member, the Secretary said that of the £187 arrears of subscriptions when the balance sheet was made out, one-half had been collected since.

Another member asked as to the meaning of the item £4 17s. 6d. professional charges.

The PRESIDENT said there had been a meeting of the Branch secretaries to discuss the accounts generally, and how to collect subscriptions, etc. The Council wanted to stiffen the position and the auditors went to Leeds to meet the Branch secretaries. The item in question represented the auditor's expenses in connection with that visit.

It was then suggested that in the publication of the report in the "Proceedings" the word "auditors" should be inserted to give some indications of the meaning of the item.

The PRESIDENT: That shall be done.

The report and accounts were then put to the meeting and adopted.

Election of Officers.

The PRESIDENT said he had very great pleasure in making the most important of the proposals for the election of officers. They were very glad to have the chance of getting the services of Mr. W. Mayer

as President for the next year. Mr. Mayer had been a member of the Association since the start, and on one occasion he had described himself as an enthusiastic foundryman. That was the sort of man who was required as President of the Association, and he felt certain that under the guidance of Mr. Mayer, the Association which had done so well in the eleven

MR. J. ELLIS (Luton).
(*Senior Vice-President.*)

years since it was formed would go on to further successes and gain new honours. During the time he (Mr. Gimson) had occupied the position he had been very proud to be there. He felt himself unworthy of the post in many directions. He had neither the scientific nor practical knowledge of many of the members and in that respect the Association was going to have someone as President who knew the foundry trade a great deal better than he did and one who knew it from top to bottom. Mr. Mayer was in every respect an admirable man for the post. He came from a part of Britain which always gave us good leaders in different directions. It had been remarked before that at nearly all the Branches of the British Foundrymen's Association, whether Birmingham, London, or wherever it might be, if one listened to the discussions there was always a strong Scotch accent and it was very suitable indeed that a Scotsman should be proposed as President.

MR. W. F. BAGNALL, in seconding, said that Mr. Mayer was not only a practical business man but a practical foundryman. He did not think there was anything in connection with the foundry trade upon which they could not get assistance from Mr. Mayer, and it was with the greatest possible pleasure that he seconded the proposal that Mr. Mayer be appointed President.

The motion was put to the meeting and carried with acclamation.

MR. MAYER, in taking the Presidential chair, said he valued and honoured the confidence which had been placed in him in electing him President. He held that it was the highest honour that could be conferred upon any foundryman. At one time, when a young man, it used to be held to be the highest honour to be master foundryman in Woolwich Arsenal. That, however, was only one department—one shop—but the Association had brought everyone into the fold, and to be President was to represent the whole of the country. He valued the honour most highly and would do all he could to carry on the work of the Association as President in the best interests of the Association. As Mr. Gimson had said, he gave way to none in his enthusiasm for the foundry trade. He felt it had been neglected, and needed some one to give advice and let outsiders know who and what they were. He would endeavour to carry on the traditions of the Association, and if he could not add to them, it could be depended upon that they would not be any worse when they left his hands. Likewise he assured the members that as far as his health and strength permitted he would visit the Branches and do what he could to encourage them and do anything and everything to bring fresh honour and better recognition for foundrymen generally.

The PRESIDENT, in proposing Mr. J. Ellis (of Luton) as Senior Vice-President, said the majority of them had been associated with Mr. Ellis for a good many years and he had always been impressed with the kindly and intelligent way with which he took matters in hand and his enthusiastic way of dealing with things. In electing Mr. Ellis they were getting the right man in the right place.

MR. R. BUCHANAN, who seconded, said the Association was certainly strong on the practical side as regards the "government" this year and he had no doubt that Mr. Ellis would give the most loyal support possible.

MR. T. H. FIRTH (Sheffield).
(*Junior Vice-President.*)

The proposition was carried with acclamation.

MR. ELLIS, in thanking the members, said that as long as the Association existed it would have a very large part in his thoughts, and everything he could do should be done to further the interests of the Association. He had been in the Association since the beginning and he would do his best to uphold the

high prestige created by his distinguished predecessors.

Mr. F. J. Cook said he had the greatest pleasure in proposing that the junior vice-president should be Mr. Thos. H. Firth, of Sheffield. It had been said by Mr. Gimson that it was desirable that the head of affairs should be one well versed in the foundry trade. In that respect Mr. Tom Firth would vie with any who had gone before or would come in the future. In addition there was one quality required in the President of an Association such as this, viz., general business ability, and in that respect he was quite sure that Mr. Firth, when he came to take up the position of President—which he hoped he would do in due course—would bring to bear upon it those great qualities of business ability which he possessed and which would be to the benefit of the members generally and the trade in particular.

Mr. W. H. Aston, in seconding, expressed his conviction that in Mr. Firth they had a man well qualified, when the time came, to fill the presidential chair.

The motion having received cordial approval, Mr. Firth expressed his appreciation of the honour conferred upon him and his determination to do all in his power to assist the new president and senior vice-president in the furtherance of the interests of the Association.

The President, who next proposed the re-election of "our very old and valued treasurer," expressed his regret that Mr. F. W. Finch was not present. He well recollected, he said, the first meeting in Manchester when everyone was in fear and trepidation, and nobody felt the strain more than Mr. Finch, who really was the man who engineered the whole thing through. They all knew how earnest Mr. Finch was and how willing he was to help the Association in any way.

Mr. J. E. H. Allbut seconded and heartily endorsed all that the president had said.

The motion was carried.

Mr. S. A. Gimson said it was very suitable that he should move the next resolution, viz., the re-election of Mr. E. A. Pilkington as Secretary, because he probably knew his work best. Mr. Pilkington began as secretary at the same time that he (Mr. Pilkington) became president and they were two new brooms which tried to sweep clean. Perhaps they did not know everything at first and they probably both made mistakes, but Mr. Pilkington had been an exceedingly earnest secretary, and had done the work admirably. He had been an excellent help to the secretary during the past two years and any work required of him was done quickly and faithfully. He had been careful in his work and not backward in making suggestions, which was always a useful thing for a secretary to do.

The President, who seconded, said that Mr. Pilkington was not a man of many words and was not one of those peculiar secretaries who tried to keep the president and everybody else right, but he did his work well.

The motion was carried.

Mr. F. J. Cook proposed the re-election of Messrs. Creke, Harcourt & Company as auditors. Mr. Harcourt, he said, was appointed when the Council decided a year or two ago to have an outsider to see that the accounts were kept on strict business lines. He had done his work well and to the satisfaction of the Council and the Finance Committee. The suggestions he had brought forward had been most beneficial to the Association and the manner in which the accounts were looked after would bear comparison with any Asociation of similar size and nature.

Mr. M. Riddell seconded. He regarded this, especially in present circumstances, as one of the most important appointments the Association had to make. In the past the auditors had shown they were able to look after the financial department, and there was little doubt they would continue to do so.

The motion was carried.

The President said the next business was the election of members of council. Since the nominations had been made, Mr. H. Sherburn had been elected president of the Lancashire Branch, and became *ex-officio* member of the Council. Consequently it would be necessary to elect six members of Council instead of five.

Mr. Gimson explained that in accordance with the resolution passed two years ago, the number of the Council had been considerably reduced, viz., to 10, five members being elected at each annual meeting. Mr. Sherburn was one of the five who was elected last year and his election to the presidency of the Lancashire Branch created another vacancy now. The sixth member elected now would only serve for one year, as he would take the place of Mr. Sherburn, who only had one year to serve.

Messrs. Cook and Buchanan were elected scrutineers for the ballot.

Mr. J. W. Worrall suggested that in future the pattern-making section of the Association might be better represented on the Council, with the idea of bringing in more pattern-makers.

The President said it was right and proper that the various interests represented in the Association should be represented on the Council.

Mr. Cook said this matter was entirely in the hands of the members. They had to suggest the nominations for membership of Council, and if those who had raised the matter would look after it another year, they would be able to do better.

The President said the question should be borne in mind, and if Mr. Worrall would keep the point before the Council it would be carried out.

The result of the ballot for new members of Council was as follows:—Messrs. J. E. Allbut, H. Pemberton, T. Swinden, W. F. Bagnall, J. G. Robinson, and C. Heggie (one year).

Alteration to Articles of Association.

Mr. Gimson said the Council had come to the conclusion that an alteration was required in Rule 3, which defined the membership. It was not desired to alter the membership, but it was thought desirable to more clearly define it. The old rule was a little invidious and it was not quite clear what was meant by it. The altered wording, he thought, would more clearly express the intention of the Association. The suggestion was that Rule 3 should read as follows:—

"The Association shall consist of members, associate members and associates, at an annual subscription of one guinea, 10s. 6d. and 3s. respectively. Foundry proprietors, directors, managers, metallurgists, consulting engineers, chief draughtsmen, works engineers, and foundry and pattern-shop foremen can join the Association as members or associate members.

"Associates shall comprise any individual connected with foundry practice or interested in foundry progress not included in the above. An expert workman shall not be debarred from joining as a member or associate member if he pays the necessary fees and is accepted by the Council. All classes of members shall have the privilege of attending any meeting held by the Association or its Branches, but the printed 'Proceedings' shall only be issued free to members and associate members."

Mr. Gimson said the intention was that those persons mentioned in the first paragraph could not come in as associates; they must pay 10s. 6d. at least.

It was simply a matter of defining the position more clearly. He did not think he need speak upon it, and he would simply move that the alteration be made. It was not intended to throw anybody out of membership. It provided means for acting in the future.

The PRESIDENT seconded. The intention was to enable the workmen to join the higher classes of membership and so obtain the "Proceedings," which were of great educational value. It was a great pity that all classes of members could not get the "Proceedings."

The alteration was then put to the meeting and carried.

MR. WILLIS said this matter had rather taken him by surprise, and he had intended speaking upon it. If he were allowed he would like to say that the paragraph relating to associates made it difficult, in his opinion, for associates to join. It seemed that they would come in by the favour of the other two classes. It would be so much better for the democratisation of the Association if workmen could join freely, but the new rule made him a sort of third-rater to come in by favour. Looking at the rule broadly there was an implied insult to the workman, for it was said he could join if he paid the necessary fees and if accepted by the Council.

MR. GIMSON explained that the whole object of the alteration was to make it easier for the expert workman to join and not to prevent him. As to acceptance by the Council, all classes of members were subject to that.

MR. WILLIS said the acceptance by the Council was emphasised in the case of the workmen and not in the case of others.

After a short discussion it was agreed to delete the words "if accepted by the Council" in the first paragraph, and add another rule, as follows:—

"All classes of members must be passed by the Council."

Presentations.

The PRESIDENT said he had now a very pleasing duty to perform, and that was to present an illuminated address to their esteemed Past-President, Mr. C. Jones. Everyone would agree how worthy Mr. Jones was of this honour, and he thought he would be expressing Mr. Jones' feelings when he said he would treasure the address, and that it would become a family heirloom.

MR. JONES, who expressed his thanks for the testimonial, said that for him the pleasure of occupying the chair was sufficient reward. To think that he really came as a stranger amongst them from the hills of Wales and that they had thought him worthy to occupy the Presidential chair, made him feel very proud. He had started in the industry in the little town he came from—which was a big city now—in 1864. There were even then no less than five foundries where iron was melted by turning a big wheel by hand. To-day, of course, there was nothing of that kind. When he took a turn at the wheel for a spell, to think that he would in time become President of the British Foundrymen's Association was beyond all his dreams. He thanked them most sincerely for the presentation, and appreciated the mark of esteem, which he would always look upon with pleasure and pride.

The PRESIDENT, referring to Mr. Jones' remark about the wheel, said it was sometimes said that moulders had no spirit about them, but he was once seeking work, when a young man, and wanted a job badly. He came across one of those foundries where they made the blast with the wheel, and when he saw a man turning the wheel he would not ask for a job at the foundry for fear they might put him to do wheel turning.

He still had another pleasant task, and that was to present an illuminated address to Mr. Allbut in connection with the very valuable services he had rendered to the Association as secretary, when a secretary was very needful. Mr. Allbut did a great deal of the pioneer work in putting the British Foundrymen's Association into something like its proper position. He was still a comparatively young man, but his position had improved and he had found himself unable to carry on the secretary's work. The Council, however, on behalf of the members, wished to express its appreciation of Mr. Allbut, and asked him to accept an illuminated address.

MR. ALLBUT said he greatly appreciated the kind words of the President, and also the feelings of the members. He had had rather an arduous time at the commencement of the Association; when he took over the secretaryship, there were 250 members, but when he had to give it up there were nearly 1,000. It was hard work, but at the same time a great pleasure, for it had enabled him to make many friendships, and he was sorry to have to give up the work. He was pleased to think that the Association was not only growing in numbers, but in influence, and it was an honour to anyone to belong to it.

Secretary's Honorarium.

On the proposition of MR. R. BUCHANAN, seconded by MR. W. H. ASTON, the meeting voted the usual honorarium of 40 guineas to the Secretary.

Vote of Thanks to Council.

MR. J. J. HOWELL proposed a hearty vote of thanks to the retiring President and Council for the manner in which they had carried on the work of the Association during the past year. They were all sorry that Mr. Gimson was leaving the chair. He had been a kind of father to them, and although when they first met him they were afraid he would be a very autocratic sort of fellow, they quickly found that he was not, and they were all delighted to make his acquaintance. As regards the members of Council, they had done much good work, and although it had often entailed long railway journeys, he was sure the work had been a great pleasure to them. The whole of the rank and file were delighted to be managed by such fine officers.

MR. B. F. SPERRING seconded. Those who visited Leicester, he said, would never forget the way in which the President entertained them and carried out the arrangements.

The vote of thanks was given with acclamation.

MR. GIMSON thanked the members very heartily for the way in which the vote of thanks had been given to the officers for their work during the past year. As far as he personally was concerned, the time he had been connected with the Association had been one of the happiest. He had felt the honour to be a very great one. He had been exceedingly interested in the Association, and wanted to do all he could to help it. As he had already said, he had felt conscious that as regards qualification for the post, he had distinctly the poorest qualifications of any President they had yet had, but he had done his best in the work, and had enjoyed it. His visits to the various branches had been visits of very great pleasure indeed. What had been done by the Council had been done from the very bottom of their hearts. It was a great thing to try and do the best they could for the business they were concerned with, and if they had been able to make things a little easier for those working in the industry and making the honours that

came to it greater, and more worth having, he was quite sure they had been rewarded by that.

The PRESIDENT then delivered his Presidential Address as follows:—

Presidential Address.

We are meeting to-day for the second time during the twelve years' life and progressive existence of this, the British Foundrymen's Association, in London—the only London, the old, great and historic London, whose streets have never been polluted by the tread of an armed conquering host. I am confident, regardless of the huge war that the country is engaged in at present, that Britain will be Britain to a man and that at the finish of the war, Britain will be Britain still.

The cry of war ringing in our ears, coupled with the urgent demand for arms, armaments and munitions of war, is somewhat interfering with, and for the time being checking the sound and valuable progress that we have been making in the past; and so, owing to conditions over which we have no control, instead of celebrating the British Foundrymen's Conference for 1915 (at which, under normal conditions, we should have had lectures on practical foundry subjects, and looked forward to fraternising together and exchanging ideas with each other on many foundry subjects, and even agreeing to differ in our opinion in the greatest of good fellowship), we are compelled to be satisfied with holding an annual business meeting of one day's duration to confirm and carry out the rules of our Association. Owing to the war cloud over our country and to so many of our members having taken up arms in defence of their country, and as others of our members in the foundries all over Britain are working hard and assiduously in producing the great quantity and variety of castings that are required and which form such an important part in defence of the country, "business as usual" is not advisable on this occasion. Britain must in her welfare have the very best we can give her in *thought, actions and deeds* to bring about the great lasting peace that the world is wanting, and if our annual meeting is shorn of the greater part of the attractions usually associated with a well-arranged and planned Conference, we can take consolation to ourselves for the good, valuable progressive work that has been done in the past, both by the parent Association and the Branches in the different parts of the country.

The slight stoppage or set-back of the Association's valuable work gives the opportunity of reviewing what has been done in advancing the progress of the foundry trade in the past. By looking at the great importance of what is produced in the various foundries, compared to the other skilled branches that go to form what is known as the allied engineering trades, we may define our position in the engineering trade.

Iron founding commenced in this country with the successful advent of the rude, primitive blast furnace blown with large bellows made of ox hides, when it was proved by demonstration that pigs of cast iron could be made. They were then made in a way in many respects similar to that in use to-day, and from that era dates the beginning of the iron founder's troubles and triumphs. The foundryman's troubles and triumphs have gone on from that day to this, as he has persevered in making and trying to make castings from pig-iron and ingots in every known metal that can be melted—metals with high- and low-melting points; metals stronger and weaker in their natural states; metals with varying contractions; metals that carry increased risks owing to them contracting quickly just past the setting stage. Along with all this there is the positive fact, which is most apparent with cast iron and cast steel, and where large block pieces and pieces of varying thicknesses are cast, that these metals expand just before the final stage of setting or freezing in the moulds; and when the moulds made of sands of various kinds are filled with metal and have to stand the searching strain and the weight of that molten metal, it is demonstrated that iron, one of the strongest metals known, is being controlled by sand, one of the weakest materials known.

There is no wonder, then, that with the many intricate influences there are to control in the making of castings there are sometimes disasters and costly firework displays in foundries that can only be got over by the foundrymen taking heart and striving and trying again. In the making of a bad casting there is also involved the cost of breaking it up, as when a casting is known to be defective in the process of making, or if it turns out defective in the dressing or machining, it is entirely bad and lost, and cannot be altered and corrected, or any part of it be saved or used. In all the other branches of the engineering trade this can be done to some extent, which conclusively proves that the moulding of sands for intricate castings is a risky, skilful, and difficult trade; and as the moulder cannot get inside his moulds to see if everything is going on all right when they are being cast, his work is very different to that done in other trades, where every movement and operation is open to view and inspection and can be brought to a stop or started at will as found necessary.

In the old far Eastern countries, where moulding and casting in sands has been known and practised the longest, founding is called the "mystery trade," which shows that even in early days it was realised that to produce castings a knowledge of the sciences was an important factor. With the advent of iron founding many things became possible that previously had been desirable and devoutly to be wished for. We can picture the rude, primitive methods employed in mining, especially in coal mining—that great national asset of this country—before the development of iron castings in the numerous uses they can now be put to in that industry.

In the production of the steam engine, Watt despite his great gift of common-sense, science and the ability to use and apply it, could never have brought his ideas to the pitch of conclusively proving that the steam engine was possible; the great future before it could never have been realised but for the invaluable assistance that he got from iron founding and the foundryman. Engines in his time were practically all of cast iron. The same statement also applies to Henry Bell, in producing the first successful steamship, the "Comet." In the same category is Arkwright, with his weaving or spinning machines, and the great changes that have been wrought by improvements since then in textile machinery. The foundrymen of that day played a part equally as important as they are playing to-day.

Agriculture did not benefit as much as it might have done by the early success of iron founding; farmers and tenant farmers still hung on to old ways and means, such as wooden ploughs and wooden everything, shod or strengthened here and there with a little malleable iron. Malleable iron at that time was both scarce and dear, being £60 per ton until Henry Cort, the ironmaster of Gosport, with his great foresight and keen discernment (and to whom a statue should have been erected in gold for what he did for the world at large and Britain especially) saw what it was possible to achieve with iron. He took

ont patents for the puddling furnace and grooved rolling mill, and by his system the cost of making malleable iron was so largely reduced, and the production so much increased, that railways became possible that previous to that had been impracticable, owing to the great cost of malleable iron. Cort must, therefore, rank as one of the earliest railway pioneers.

Coming to more modern times, we may recall what the iron founder has done for the health and comfort of people all over the world. He has produced huge quantities of cast-iron pipes of all sizes and forms for the conveyance of water from both high and low altitudes where it is most abundant and for the carrying of it by natural gravitation or forced pumping for long distances, over hill and down dale, to places, cities and towns with huge populations. In a similar way cast-iron pipes are doing the principal part in dealing with the very important work of sewage disposal. Consequently, every country that to-day has dealt in a proper way with its water supply and sewage disposal is able to keep free from the scourge of the plague, pestilence and epidemics which would otherwise be common. Yet how few of the millions of people who have benefited by the great progress made in this respect know anything about the foundrymen, as to who they are, what they do, or the part they have played in bringing the great blessing and boon of a good water supply into their midst. It is now brought into their very houses and contributes largely to their better health by cleanliness, and demands the expenditure of no labour or energy on their part, otherwise than the turning a tap on and off.

A similar case is that of the introduction and distribution of coal gas, which was known to exist long before the invention of gas lighting. Murdoch saw that it was possible to bottle up gas and convey it in any quantities to where it was wanted, by the use of cast-iron pipes, with the necessary controlling valves. Here again, an important part has been played by the foundryman in making the prime mover to dispense gas to wherever it is wanted to meet the needs and requirements that gas as a power or an illuminant has been applied to. If further proof of the foundry's services were necessary, we might refer to the various kinds and types of gas engines—internal-combustion or oil engines—and electricity-generating plants of all kinds. These immense providers of power are now found all over the world, and almost the whole of the parts of these engines are the products of the foundry. This speaks volumes for the importance of the foundryman and his art or trade. It is interesting to note that even the mile posts or road marks are now made in cast iron, and what a great improvement they are on the old milestones. How quietly the change, like many others, has taken place, whereby the products of the foundry have been brought to the service of the great crowd of wayfarers. It comes to them as a "don't-know-how" change, as they have no knowledge of who they are indebted to—they know nothing about the foundryman or his art. There are other similar examples, too numerous to mention, whereby the foundry is contributing a very large quota to the progress, wealth and comfort of the people of this country.

During my long and active connection with the foundry trade, especially iron founding, I have seen many changes and improvements of all sorts applied to foundry practice, and in not a few cases I have been personally concerned with their success, and also with some that have not been a success. Yet it is recorded that foundrymen are looked upon as non-progressive and conservative; that they will not move with the times; that they work by rule of thumb, and that their two-foot rules should have nothing less than quarter inches on them. It has also been suggested that they are deficient in language, and that they even cannot express themselves fluently concerning the details of their own trade, because of the use they make of tobacco as a stimulant. Such suggestions are both untrue and malignant and originate from sources that have no knowledge whatever of the many intricacies that the foundryman has to contend with in producing castings. The slur of non-progression does not apply, because the foundrymen have always been able to produce whatever supply has been wanted in connection with any improvements and modern developments and requirements, no matter in what direction, and this often without the aid of modern tools, and in foundries in unsuitable, out-of-the-way and unapproachable places.

Coming to the money side of the trade, *i.e.*, wages that we all work for, it is interesting to note that moulders' wages have doubled since I first went to the foundry trade. The hours then were long and the work hard, with not a fraction of the games, amusements and recreations there are now available for the people. Being "run down" and being ordered by the doctor to take a rest and change was then unknown; but the moulders, mostly the old moulders, had their own way of dealing with the necessity for rest and recreation by going on the "spree" for days and weeks sometimes; and I have heard them maintain many a time that their work was such that both physically and mentally they needed a rest.

The introduction of the marine engine and other large intricate castings gave a great fillip to the foundry trade and created a demand for a much larger number of skilled moulders than had been required before. About this time it was customary among some iron founders to lend their best and highly-skilled moulders to each other when they had any very special castings to make. Another trait that was characteristic of those times was the application of the word "luck" to the success or non-success of making castings. There is no such thing as luck having a predominating effect on the successful making of castings in the foundry; but there are results and their causes, and there are correct ways and means of getting the results. The practice of blaming luck for the want of looking after the intricate trifles which make perfection in the foundry is now, I am pleased to say, a thing of the past.

Books on foundry practice, and foundry literature generally, were practically non-existent in those times, so that the foundry enthusiast and student in search of knowledge had little help in trying to get his own ideas approved or amended. Being not only an enthusiastic foundryman, but also a lover of books, it is a trial for me to go past a bookshop, especially a second-hand bookshop, without having a look at what is offered. On one occasion my eye was attracted by a book entitled "Rough Castings," which suggested the thought that it might be something new and perhaps contain knowledge and information on the foundry trade, and that my long-seeking and searching was about to be rewarded. But on getting the book into my hands I found it was a volume of poems, the author being no less a person than the late William Allan, who died a few years ago, Member of Parliament for Gateshead-upon-Tyne. He was a well-known and an advanced engineer—a wonderful man in many ways, and a striking personality in himself. He was engineer on board a blockade runner during the American Civil War, and it is recorded that on one occasion when hard pressed by the enemy he sat on a boiler safety valve, vowing that if they did not elude their pursuers they would certainly never be arrested. This same gentleman had the

laying down and the control of a large marine works, when he conceived the idea, which he carried out, of putting all the various branches of engineering under one roof; putting the foundry at the bottom of the works in one bay and the boiler shop at the bottom in the next bay, with, of course, offices and drawing office at the top of the works; then followed the fitting, turning, and erecting departments. But these open-as-the-day arrangements did not work very smooth or satisfactory, as the foundry, with its fumes, moisture, vapours and fine dust, began to "talk back" to the machinery, and gave the machinery a dose of rust freckles and the itch. I have not heard of a similar trial being made elsewhere. However, the foundry and the importance of its moulders had evidently impressed themselves on the poet. I will just quote one verse:—

"All day building compound engines,
Is the glory of my time;
But at night I with a vengeance
Mould my thoughts with tools of rhyme."

Those times were contemporary with the advent of the compound marine engine, and what marvellous progress there has been since then in every art and trade. During that time the whole of the people of Britain have had a liberal education, according to their various talents, with an abundance of cheap literature of all kinds for their guidance. Even the long-neglected foundry trade has now got its long-needed journals and books in abundance; and pleased am I to record the fact that it is a tax now to keep up-to-date by reading all the foundry literature there is for perusal. As an instructive comparison, I quote from a lecture given by Mr. A. Laird to the London Association of Foremen Engineers in 1872 entitled "Properties and Treatment of Cast Iron." The lecturer stated that an eminent and one of the most prolific of our scientific authors had informed us that the success of the modern compound marine engine depended in a great measure upon the employment of steam at a much higher pressure than was then common or possible. The working pressure of the compound engine was 80 lbs., and to-day the ordinary working pressure of the marine engine is 220 to 240 lbs. The lecturer gave no analysis of cast iron nor any explanation of the causes and reasons why some irons were strong and others weak. Of course, metallurgical chemistry at that time had not attained to anything like its present-day usefulness and perfection, with the rapid systems of making analysis. So rapid has been the progress of metallurgical chemistry that it is to-day within the reach of every foundryman and fills a long-felt want, not only as a guide in the selection of the most suitable irons, but in reference to cokes, fuels, sands and blackings—in fact, everything that is used in the foundry.

Having briefly described the part that the foundryman with his products has played in the advancement of the world and its requirements, we may look around and enquire what the world, and the foundrymen themselves in particular, have done in the way of commemorating by erecting monuments and momentos to pioneer foundrymen such as Abraham Darby and others since his time, who have done so much for the foundry trade. But we have to admit that such recognition is nil, and because we have been forgetful, remiss and long in acknowledging and doing these things, and their accomplishment is better later than never. I take this opportunity of bringing the matter under your notice, with the earnest desire that you will give it your serious thoughts and consideration, and ventilate it amongst foundrymen on every suitable occasion. To bring this laudable object to a practical result should not be a difficult matter now that we have the British Foundrymen's Association established on a firm basis. It has already done a great work during its twelve years' existence, not only in educating foundrymen but in uneducating them as well, all over the length and breadth of the land, by means of lectures in our various Branches and articles in the foundry journals, many of which should have been written in letters of gold on account of their real sterling practical value. These lectures and articles have not embodied the make-belief and subterfuge of which so many lectures are composed, but they have been articles on practical foundry subjects by practical foundrymen, and have been reasoned out in the proper way and have given information and advice in a sound practical way without any reluctance whatever. By this work the whole of the foundry trade has been benefited to a very large extent, and I take this opportunity to say that those who have benefited the most by the great educative work that the British Foundrymen's Association is carrying on are the master founders and all those who have become ironfounders and partners in iron and other foundries by investing their capital and associating themselves with the foundry trade with a view to a satisfactory return for their investments. Those persons are wanted in the Association, and it is their duty to become members and thus set an example to their foundry managers, foremen, assistant foremen, chargemen and all those engaged in assisting to carry on the great volume of the foundry trade.

While we have made fair progress in increasing our members in late years, yet the increase in membership has not been anything like what it should and might have been, when we consider the great numbers that are associated with and engaged in the foundry trade. Only by materially increasing the membership can the money be got that is required to carry out and develop some very desirable schemes and projects in connection with the trade. Finally, I appeal to you individually, one and all, to do all you can to increase the membership of our Association and to do everything by word and deed that you can as enthusiastic foundrymen to advance the prestige of the trade in the great and important work it does.

Mr. Gimson proposed a very hearty vote of thanks to Mr. Mayer for his excellent and interesting address. It might be described as a eulogy of the foundry trade and a eulogy that he did not think was undeserved. He had always said that the foundry trade was one of the most important trades in the whole world. The basis of our very existence was, of course, the agricultural trade, but in the further expansion of our businesses, the foundry trade came next. It was certainly the basis of all engineering, and engineering meant practically every other trade that could be thought of, even including agriculture. Therefore it was good for us to be reminded of the benefits which had been conferred upon the community by the old, ancient and aristocratic foundry trade.

The President, in expressing his thanks for the vote, said he had no axe to grind in becoming President of the Association. What he did would be done regardless of himself and in the best interests of the Association.

A vote of thanks was proposed by Mr. F. J. Cook to the Secretary of the Apprentice Committee, and this was supported by Mr. Gimson. A brief general discussion with reference to the First Report of the Committee ensued, and was responded to by the Secretary of the Committee. This subject will be dealt with in our next issue.

A Progressive Australian Foundry.

Australia has shown progress in so many lines that it is not surprising to find important advances being made in the iron and steel and engineering trades. The firm whose works we illustrate herewith (Thompson & Company (Castlemaine) Proprietary, Limited, Castlemaine, Victoria) probably stands as one of the most enterprising and progressive in the Commonwealth. Pumping and dredging plant of all descriptions comprise one of the chief classes of work produced, and some very important installations have been turned out by the works. Probably the chief feature of interest to our readers, however, is the fact that the company's foundry is the largest in the Commonwealth. A general view of this department is shown in Fig. 1. The building is roomy and well lighted, and over the centre bay is a 15-ton electric travelling crane with a fast lifting speed for weights up to 5 tons. Two cupolas are installed, the capacities being 5 tons and 12 tons per hour respectively. The blast is supplied by two high-pressure centrifugal blowers, the larger one being coupled direct to a 36 h.p. electric motor running at 1,080 r.p.m., and delivering 350,000 cub. ft. of air per minute at a pressure of 22-in. water gauge. The smaller blower is driven by a 21-h.p. motor at 1,250 r.p.m., and delivers 275,000 cub. ft. of air per minute at a pressure of 20-in. water gauge.

In an engineering foundry, naturally, all classes of moulding—green-sand, dry-sand and loam—are called into play. There are also a number of moulding machines in use for light work which is required in quantities. These machines are Farwell squeezers fitted with pneumatic vibrators.

The storage bins for sand, loam, etc., are situated at one side of the shop, and are filled from a high-level roadway outside. The material from the bins is drawn down through an arrangement of shutes and trap doors by gravitation to the rollers and mixing machines—a system which is found very convenient in controlling the supply to the moulding floor. The system of constructing the moulding boxes for large castings is that of building up with sectional frames. It is claimed that this saves making pits in the floor for such work and allows better egress for the gases in the mould during pouring. The frames also can be rapidly dismantled for stripping the casting.

A pig-iron storage yard occupies a position alongside the foundry, and the metal and fuel for the cupola are unloaded direct from the railway trucks in the yard, or into bunkers, and conveyed to the charging platforms by hydraulic elevators.

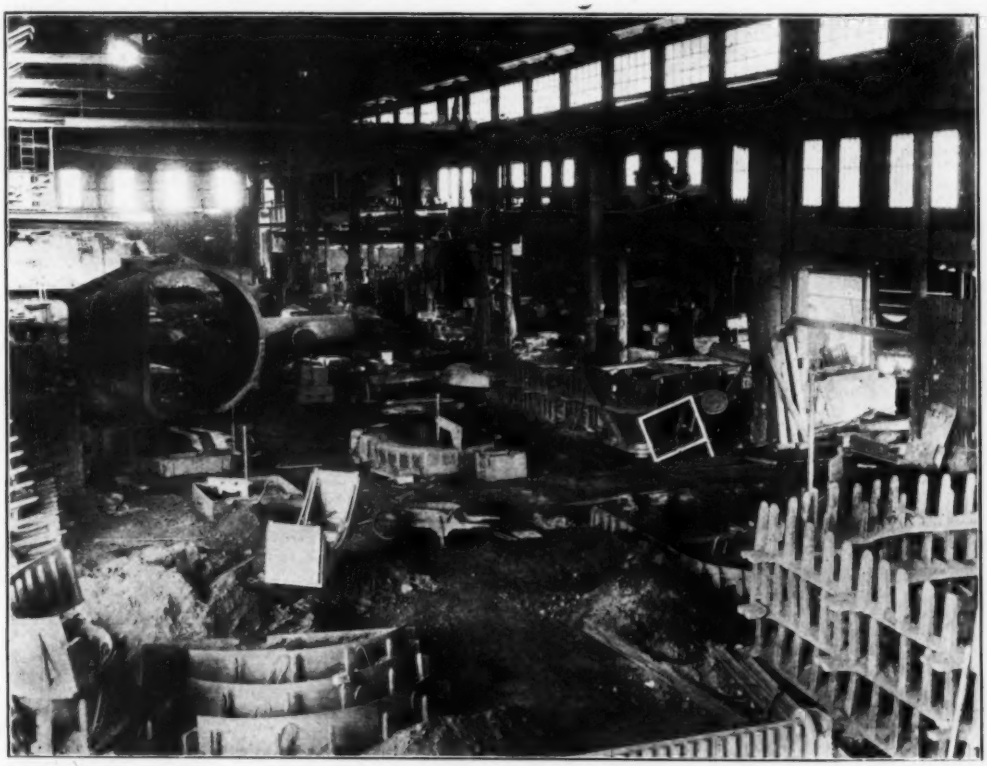


FIG. 1.—FOUNDRY OF THOMPSON & COMPANY (CASTLEMAINE), LIMITED.

The pattern-making department is situated opposite the moulding shop, and is equipped with a variety of woodworking machinery. The pattern stores are represented by a three-storey building, all patterns being systematically stored and issued by a storeman as required.

As an example of the range of work produced in the foundry it may be mentioned that recently was cast the casting shown in Fig. 3. This casting weighs nine tons, and is one of 24 for the condensing plant of the Melbourne electrification of suburban railways scheme, and is being manufactured and installed by Messrs. George Weymouth & Company, Melbourne. The making of the large castings was sub-let to Thompson & Company, Castlemaine. The method of moulding the casting shown was to make the outside of the mould first, then put in thickness strips and ram up the core, which was made in one piece and lifted out of its seating. The core in its green state is estimated to weigh 14½ tons, and is probably the heaviest core made in the southern hemisphere. The heaviest casting made by Thompson & Company was a combined bed for pump and high-speed engine. The casting was over 20 ft. long and weighed 13½ tons, and was cast during February of this year.

Another interesting department is the erecting shop, a view of which we give in Fig. 2. This gives some idea of the variety of work turned out by the

FIG. 3.—LARGE CONDENSER CASTING MADE AT THOMPSON & COMPANY'S WORKS.

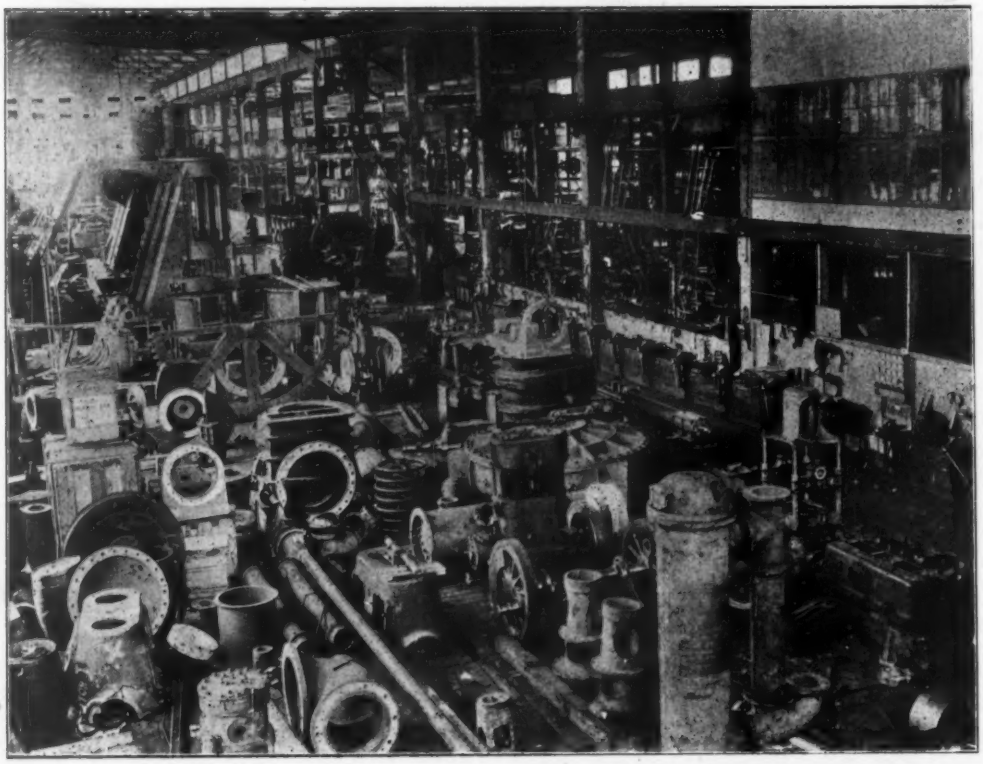


FIG. 2.—ERECTING SHOP AT WORKS OF THOMPSON & COMPANY (CASTLEMAINE), LIMITED.

company, which ranges from small pumping apparatus to locomotives, the latter being a relatively recent but very successful departure. A special locomotive department is now run, and a number of locos have been placed in service on the Victorian Railways. The other departments are too numerous for us to describe at present, but we may mention that they include a brass foundry, a well-equipped boiler shop, a smithy and forge which is considered one of the best equipped in Australia, and a special department for making all points and crossings required for the Victorian Railways.

The Cooling of Metals.

Dr. W. Rosenhain, F.R.S. (Head of the Metallurgical Department of the National Physical Laboratory) lectured before the Sheffield branch of the British Foundrymen's Association, on April 30, on "The Cooling of Metals."

The knowledge of what happened when metal cooled, said the lecturer, was fundamental to a great many things in metallurgical science and practice; many of the things that mattered most to metal happened when the metal was cooling, and in order to avoid pitfalls accurate knowledge of what it was that took place during the cooling process was necessary—in other words, a detailed and accurate knowledge of the physics and physical chemistry of the process of cooling, particularly as applied to metallic bodies when passing from a liquid to a solid condition; the theory of the process. The word theory stood in bad odour among practical men in this country; but that was largely due to a misconception. People were very apt to dismiss what they did not understand very easily as theoretical, and therefore useless; that was a very easy way out of a difficulty, as it saved the bother of learning. But it was a fatal mistake to carry that attitude too far, because theory which stood for systematic knowledge could not safely be dismissed as merely academic. If the facts established in the laboratory did not work out in practice, it must be that some factor was not understood.

The theory of cooling was a very wide subject, embracing the thermal aspect; a hot body cooling down lost its heat in various ways, such as by radiation, conduction and convection. Then the change of state involved a whole host of phenomena concerned with crystals and the laws of crystallisation, and there was also the chemical aspect involved in the cooling of alloys, and the partial or complete separation of their constituents. He proposed to deal with these three aspects.

In the first place there was the thermal aspect—the cooling of a liquid metal when poured into a mould. There could be no doubt that radiation and convection, directly, at any rate, played only a minor part in the cooling in that case. They played a part in the cooling of the mould, as, for instance, in the case of a steel ingot poured into an iron mould; but the real transfer of heat which was of interest was from the hot liquid metal to the solid metal of the mould. The main consideration to which he wanted to draw attention in this connection was that a mass of metal cooling under any conditions could only cool because its temperature was different in different parts. No mass of metal that was cooling could possibly be at a uniform temperature throughout. The reason was that heat was like water in that it would only flow down hill, always tending to travel from regions of high temperature to regions of low temperature; and if a body was losing heat it meant that its external layers were falling in temperature, and that the heat supply was being renewed by conduction or otherwise from the interior. A piece of country that sloped down could be shown on a map by contour, and exactly the same thing could be done for temperature gradients by isothermal lines. The route by which heat from the interior of a cooling mass of metal was conveyed by conductivity to the exterior would depend on the conductivity of the metal, and the rate at which the outside heat was depleted would depend on many things in the surrounding conditions, but, generally speaking, if the temperature of the metal was high the rate of depletion would be fast and the rate of filling up the heat which had been taken away would be slower, with the result that the temperature flow would be most rapid from the exterior. That he represented on the slide shown by drawing a number of circles indicating the varying temperature within a piece of metal.

The unsoundness of castings at the corners was generally attributed to the wrong cause. With a number of crystals meeting along a line, the points where the crystals met were normally points of strength, and not weakness; the reason for the weakness was a local piping at the last point to solidify. Crystals always grew at right angles to the isothermals, crystal growth proceeding from nuclei, and these only formed when the temperature of the metal had fallen to freezing point. Each of these nuclei tended to throw out arms in all directions, which would meet arms of adjacent nuclei, and the growth took place where there was least competition.

Turning to the "change of state" aspect involved in the cooling of metals, the lecturer showed the insufficiency of the commonly-accepted definitions of solid and liquid depending on the relative rigidity of the substances—as instanced in the cases of pitch, glass and liquid crystals—and urged that a more reliable and satisfactory distinction was as between crystalline and non-crystalline, or amorphous. By crystalline was meant a body consisting of particles arranged in some regular manner. Science had now obtained a very considerable insight as to the exact manner in which these particles were arranged, and in the amorphous state, the absence of such regular arrangement. What was the evidence of crystalline structure in solids? The action of transparent mineral crystals on rays of polarised light gave rise to beautiful patterns whose regularity was evidence of the regular structure of the crystal. In the case of metals it had recently been shown that in the reflection of Rontgen rays there was an optical line of evidence which clearly indicated the regular geometrical arrangement of the atoms within the crystal. The growth of a crystalline structure did not result from the building up of successive layers, but by shooting out branches until these met other branches and the intervening spaces were filled up. What was it that made the atoms of the metal arrange themselves in this way? Clearly there was some directing force which made the atoms turn and arrange themselves, and determined whether a given atom should adhere to one crystal or to another. It would appear that the attractive force acting on the atom from one crystal was greater than those acting upon it from another. But ultimately a point must be reached between two growing crystals where the opposing forces of the crystal growths were nearly balanced and the atom was not impelled very strongly one way or the other, and therefore did not range itself definitely on either side. The effect of two such opposing forces was very clearly illustrated in the attraction of iron filings by the two similar poles of a magnet (as shown by means of a slide) between which there was a distinct neutral ground where the two opposing sets of forces were so nearly balanced that the particles of iron arranged themselves in a completely indifferent manner. So in the case of a cooling mass of metal, there would be a neutral zone between any two crystals where the atoms would go on cooling down without arranging themselves in crystalline order. This amor-

phous or non-crystalline layer between the crystals of metal would have the hardness characteristic of all under-cooled materials.

The lecturer then discussed what would happen in the case of pure iron, which would consist of crystals of iron, with these amorphous layers between them. The amorphous layers should be stronger and harder than the crystals themselves, and if strained or deformed there should be very little movement at the boundaries of the crystals, all the movement taking place within the crystals themselves. That the deformation took place by the deformation of the crystals themselves, was shown by means of slides. A temperature of 900 deg. Cent. however, approached somewhat to the softening point of the amorphous layers, while the crystals melted suddenly and changed from the solid to the completely liquid at a much higher temperature. At such a temperature as 900 Cent., nearly all movement took place by the sliding over one another of the boundaries. Thus the flow of these metals at high temperatures obeyed the law of the flow of v scous liquids. To carry the process a little further, the deformation might be continued until rupture took place; in the cold metal the crystals broke across but at a suitable high temperature the crystals could be pulled apart from one another quite easily, so that the fracture followed the crystal boundaries. Several slides were shown illustrating the varying course of the fractures at different temperatures, with various metals, including purest gold, to show that the action was not attributable to the presence of impurities, as was sometimes suggested by opponents of the theory which was also confirmed by experiments in vacuum.

Experiments in latent heat also, in the opinion of the lecturer, clearly indicated differences which would be very hard to explain on any other physical ground. He was quite prepared to admit that there was no definite proof of the existence of this "amorphous cement," but some people would never be convinced until one could hit them with a piece of amorphous metal. At the same time he thought there was enough evidence to indicate that there must be something in the theory. It explained the difference in the mechanical properties of metals, which depended upon the size of their crystal structure; and the curious difference in their elastic limit was very readily explained by it. It also served to give a reasonable explanation to that most puzzling of all facts, that a very small proportion of impurities produced such enormously disproportionately large mechanical, electrical and other effects; these added bodies would always tend to concentrate themselves in this amorphous cement, and might account for the large effect of vanadium in steel. This, he thought, was one of the most fruitful applications which the theory offered, but a good deal remained to be done in working out these applications; it showed why other things injured steel, because they spoiled the binding power of this amorphous cement.

The third portion of the lecture dealt with the physico-chemical aspect of the cooling process, the separation of the various constituents of alloys, the formation of solid solutions, and the formation of "cores." These latter, Dr. Rosenhain explained, were due to the rate of cooling; only by slow cooling could a completely homogeneous crystalline aggregate be obtained. He showed how by annealing and working the cores could be got rid of. The reason for a limitation of phosphorus in steel specifications was also insisted upon; fissures in shrapnel shells were attributable, in the lecturer's opinion, to regions of low carbon and high phosphorus, resulting in layers of different hardness. The remedy was to eliminate the phosphorus as far as possible, or to render its distribution uniform. One way was to decrease the speed of solidification of the steel, and if that was impracticable, the next best thing was to anneal the steel very drastically at a certain stage in the working.

Discussion.

Dr. Percy Longmuir assured Dr. Rosenhain that no industrial centre was more ready to discuss and welcome theories than was Sheffield, where science had for long been recognised in the works. Sheffield manufacturers were only too ready to test a theory and if found of practical value to utilise it. The principle of diagonal lines of cooling in the case of thin plates was familiar in foundry practice and the cracking effects described by Dr. Rosenhain were generally considered as being due to warping at temperatures distinctly lower than the solidification point.

Dr. W. H. Hatfield remarked that there were several points upon which he was afraid he could not agree with the lecturer. For instance, the amorphous theory must yet be considered as only tentative. The theory was certainly of interest and had proved of service in so far as it had led to the bringing forward of much new evidence concerning the internal architecture of metals. Some of the experiments, however, upon which the theory was founded had not yet been subjected to that broad criticism which they deserved. The difficulty with a theory like the amorphous one was that it demanded a more intimate acquaintance with pure science that might reasonably be expected of many technical metallurgists whose problems it sought to explain. Dr. Rosenhain pointed out that with increase in temperature, the amorphous phase existing between the crystals in a metal became much less viscous, with the result that the crystals pulled apart. It seemed to the speaker that if the amorphous material would develop such weakness at the temperatures in question, the rigidity obtained in the amorphous material at normal temperatures meant an increase in strength out of all proportion to the increase in hardness of the crystal itself with lowering temperature. He also thought that Dr. Rosenhain was entirely mistaken with regard to the segregation of phosphorus in the steels mentioned. That, of course, depended upon the value of the reagent which Dr. Rosenhain had brought out some months before, and the speaker considered that the reagent was of extremely little value.

Mr. Saniter (Rotherham) said he had a very open mind with reference to the amorphous-cement theory, and thought the facts brought before them deserved the most careful consideration; he did not see how they were going to explain the differences otherwise than by some such theory. It occurred to him, however, as doubtful that some other metals used as alloys in steel would have influence on the amorphous layer, by concentrating in it. The metals added to steel melted at practically the melting point of iron or a melting point above iron; it was quite possible that the melting point of the alloys might be lower than the melting point of the iron, but the absence of segregation rather negatived the view of concentration in the amorphous cement. He agreed that it was desirable to have as little phosphorus as possible; he did not think in Sheffield they were advocates of high phosphorus, but always advocated making as pure a steel as possible. There was always the danger of segregation, and although there might be a low general percentage it might be high in one part. With regard to the cracks in shrapnel, was it really ascertained that the areas round the cracks were due to phosphorus segregates?

His experience was that there was oxide in a crack, and it caused a de-carburising effect.

Dr. Swinden added his thanks to the lecturer, and thought the amorphous theory did explain in a way that could not otherwise be explained, many of the phenomena in the physics of steel and other metals. He questioned the lecturer's conclusions in regard to the influence of phosphorus segregation in producing "rokes," because it had a tremendous bearing on industries vital at the present moment. It was of the highest importance to ascertain whether or not the presence of phosphorus had any bearing on the occurrence of surface cracks.

Dr. Rosenhain, replying to the discussion, thought that Dr. Longmuir had made a mistake in confusing the internal temperature with the outside in saying that the contractions led to cracks 200 or 300 degrees below the freezing point. Dr. Hatfield had raised a very large subject indeed, and to fully answer all his objections to the theory would occupy far too long. He thought it rather hard that he should be singled out as an exponent of the academic point of view; his whole working time was taken up with the problems of applied science. In regard to Dr. Bielby's experiments with calcite, he suggested that it was very easy to conceive of calcite in the liquid phase at the ordinary temperature in very small quantity; it was a question of the law of mass and the effect of pressure. The question of chemical decomposition would also require investigation. In reply to Dr. Swinden and Mr. Saniter, he thought there was unmistakable connection between the deep-seated phosphorus band and the location of the surface cracks. There was no doubt oxidation near them, but it was an effect rather than a cause.

On the proposition of Mr. John Little, Dr. Rosenhain was very heartily thanked for his lecture.

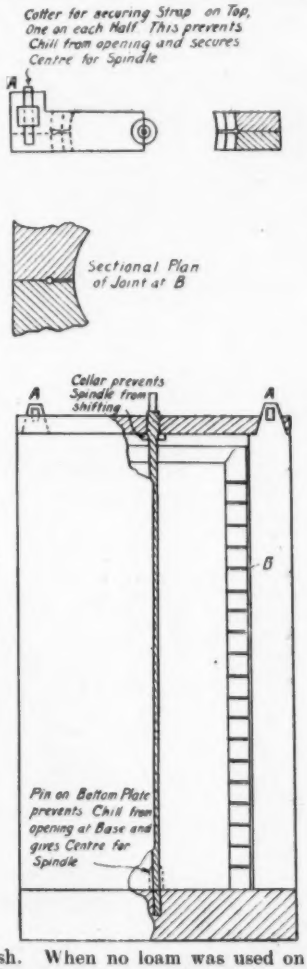
SURGICAL MAGNETS.—The removal of pieces of shrapnel by the use of powerful electro-magnets in hospitals has been acclaimed as the very latest application of science to surgery. The Westinghouse Electric and Manufacturing Company has installed in the relief department of its East Pittsburgh works a notably powerful magnet for removing metal embedded in the flesh. It is not an infrequent occurrence for steel and iron workers to get bits of metal in their eyes or hands. The portion of the body in which the foreign particle is embedded is placed near the pole tip of the magnet, the switch closed, and the magnet does the rest. The pole is removable, a number of different shapes being supplied for various classes of work.

COLD GALVANISING.—Electro or cold galvanising is now an industry of considerable importance; every shipyard of importance and every dockyard throughout the world has an electro-galvanising plant for the coating of boiler tubes in particular. All boiler tubes for the Admiralty are coated with zinc before being assembled, by the electro-galvanising process. The process is also largely used for coating iron and steel when it is important that the tensile strength should not be affected, also for machine and finished work which has threads or screws cut upon it or accurately-fitting parts, as these are not filled up as is the case if they are coated with zinc by the hot process; the coating of zinc is also evenly distributed. Mr. Cowper Coles, who erected the first electro-galvanising plant, at Messrs. Cammell, Laird's yard at Birkenhead, in the year 1893, has recently made important improvements in the process; especially in regard to the coating of small articles such as bolts, nuts and tubes, and has erected a plant for this purpose at Sunbury-on-Thames

Casting Gun-Metal in Chills.

In the report, on page 257 of our last issue, of the discussion on "Casting Brass in Chill Moulds," which took place recently at the London Branch of the British Foundrymen's Association, Mr. H. G. Barrett is mentioned as describing the casting of bronze in chills. The following fuller details and sketch have been kindly supplied:—

The rolls in question ranged in diameter from 1 in. to 3½ in., those from 1 in. to 2 in. being solid and the others cored. For the holes of small diameter a mild-steel spindle was used, and for the holes of larger diameter a piece of flax was wound spirally round the spindle and coated with loam. When the metal in the chill had gone a little below freezing point the spindle was rotated and withdrawn, leaving the loam


Cotter for securing Strap on Top, One on each Half. This prevents Chill from opening and secures Centre for Spindle
A
Sectional Plan of Joint at B
Collar prevents Spindle from shifting
A
A
B
Pin on Bottom Plate prevents Chill from opening at Base and gives Centre for Spindle

in the bush. When no loam was used on the spindle the rotating operation was began before the period mentioned. The trouble at first was uneven surfaces on the castings. The chill was then treated in the following way:—A ⅜-in. hole was drilled down each joint of the chill the whole length, and from the part to receive the metal small grooves were cut into the ⅜-in. hole. This is shown clearly in the accompanying sketch. After this no difficulty was experienced, except that the first one cast usually had an uneven surface near the bottom. These chills were also dressed with plumbago.

Sound Ingots for Shell Steel.*

By Sir Robert A. Hadfield, F.R.S.

There is not the slightest necessity that unsound material should be produced for rail or shell purposes; in fact, strange as it may seem, there is also no reason why a single unsound ingot need be produced. This is shown by the following research work which the writer has carried out during the past few years.

FIG. 1.—18-IN. INGOTS, ABOUT 2¾ TONS, MADE BY THE HADFIELD PROCESS FOR PRODUCING SOUND INGOTS.

Fig. 1 represents two 18-in. ingots made by the writer's system, weighing about 2¾ tons each. These ingots were cast with the small end up, as in ordinary practice. This photograph is interesting as it gives an excellent view of the cavity produced by the sound steel in these ingots as it settles down into the body of the ingot proper; that is, below the feeding head. In these ingots it is not necessary, in order to determine whether they are sound or not, that machining or other observation by mechanical methods should be carried out, and at least 88 per cent. to 90 per cent. of sound usable and saleable material is obtained.

Fig. 2 shows an ingot made in the present and ordinary manner; not even the most experienced expert could say whether the exterior of the ingot was sound or unsound, whereas the ingot in Fig. 1 shows the steel to have settled or sunk down. When steel so sinks it is a definite proof that the material is sound and free from blowholes. The following results further illustrate this important advance in the production of sound steel :—

To show how considerable is the cavity which forms in piping steel, nine 15-in. ingots were taken (weighing about 3,600 lbs. each), each of which had the sand head and the writer's method of feeding carried out on them. After the ingots had cooled down, the hollows or cavities in the sand heads were filled with water, then the water poured out and carefully measured. Table I. shows the results obtained.

The average weight for the nine 15-in. ingots showed that 139 lbs., with a minimum of 128 lbs. and a maximum of 162 lbs., passed from the head portion into the ingot itself. This percentage is represented by an average figure of 3.88 per cent. In other words, about 4 per cent., or 140 lbs. of the total weight of the ingot or ingots cast passed from the upper or feeding head into the body of the ingot. Let it be assumed that the cubic capacity of each of the 15-in. ingots was approximately 12,500 cub. in. But for this feeding there would be a general want of solidity, chiefly at the upper portion of the ingot, to the extent of, say, 500 cub. in.—say, 4 per cent.—of the whole capacity. It is surely readily apparent why an ingot which is not fed must perforce be deficient in homogeneity.

There is, of course, a certain amount of feeding effect from the steel in the upper portion of the ordinary ingot, but this is not done efficiently, as the steel quickly freezes on the outside of the mould and on the surface of the liquid steel exposed to the air. Moreover, there is always an uncertainty as to how good or how bad is the resulting material. In any case, as the steel solidifies in an ingot of this size, the natural law of contraction demands that about 500 cub. in. have to be dealt with on an ingot of the weight and size mentioned.

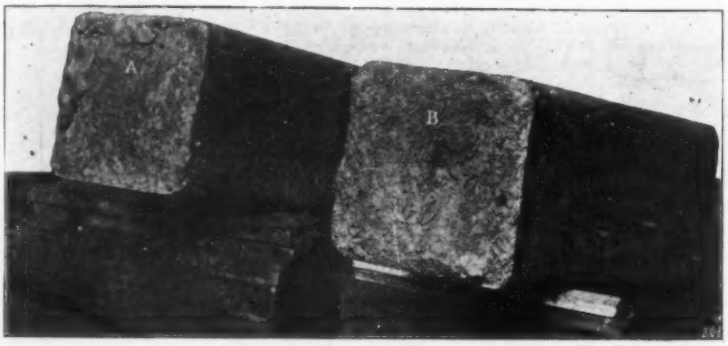


FIG. 2.—18-IN. INGOTS, ABOUT 2¼ TONS. A = UNSOUND INGOT; B = PIPED INGOT.

While the results necessarily vary slightly, because the sizes of the head portion nearest the top of the mould formed in sand are not always uniform in length, as the steel shrinks down slightly more on the outside in some cases than others, on the whole the maximum and minimum figures of 4½ and 3½ per cent. of the total weight of the ingot having passed from the head into the ingot itself show very uniform working; if the heads were absolutely the same

* Abstract of Paper communicated to the Franklin Institute, and printed in the "Journal" of the Institute for February, 1915.

depth in each case, there would be practically no difference. If not treated, the piping would have probably run down the ingot itself, requiring a discard of probably 25 to 33 per cent. Although water cannot be poured into the cavity of a red-hot ingot, yet the cavity can be determined in each ingot by a cursory examination while at a red or yellow heat, involving only a few seconds of time.

While in ingots made in the ordinary way as above mentioned a certain amount of the fluid steel passes from the upper portion to the lower, still in so doing it is robbing the quality of the upper portion of the ingot itself, which has no fluid metal above it

TABLE I.

Ingot number.	Cubic inches.	Lbs. of steel.	Percentage of weight of ingot.
1	457	128	3.57
2	549	154	4.30
3	457	138	3.57
4	457	128	3.57
5	472	132	3.68
6	488	137	3.82
7	518	145	4.05
8	579	162	4.52
9	488	137	3.82
Average	496	139	3.88
Maximum	579	162	4.52
Minimum	457	128	3.57

Weight of ingot, 3,600 lbs.

to feed or take the place and supply the deficiency thus created. It will readily be understood, therefore, why the upper portion of ingots is so seriously affected as regards their soundness, also why segregation occurs. This is shown in a remarkably clear manner by ingot B (Fig. 4). The steel in the "fed" ingots being maintained fluid in the head portion continues to exert its ferro-static pressure, whereas with ingots made in the ordinary way the ferro-static pressure on the centre portion of the ingot is so slight that it produces very little beneficial effect. Further, without the feeding head above the ingot proper, the outside of the ingot in the ordinary ingot mould becomes rapidly chilled and frozen, so that it cannot contribute its proper share to the feeding of the remaining portion of the ingot. It is not, therefore, to be wondered at that rails rolled from the A and B portions of an ingot made in the ordinary way are liable to unsoundness or piping, or both, and are also often full of impure segregated material.

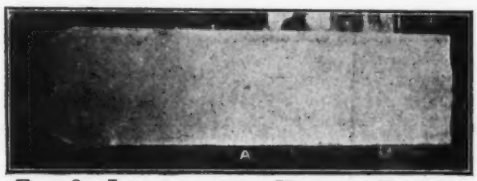


FIG. 3.—INGOT MADE BY HADFIELD PROCESS, PERFECTLY SOUND, FREE FROM BLOWHOLES, PIPING AND SEGREGATION.

There would probably be more dangerous ingots but for the fact that the steel-maker tries to avoid this type of steel, and aims to make steel which when poured into the ingot will not pipe. Nevertheless, he is still fighting against a natural law. If piping steel is checked or avoided, he runs the risk of producing unsound steel, especially in the upper portion of the ingot, more or less permeated with blowholes. Thus, owing to lack of feeding from the upper portion, the centre, or that portion on the axis line of the ingot, must be of inferior nature, as the piping characteristics persist for quite a long way down the ingot. This, as before mentioned, is for the reason that, owing to want of ferro-static pressure, the ingot lacks feeding from above, which, in the system of casting ingots now described, is maintained to a very late stage; that is, until or close upon actual solidification. There is always fluid steel in the upper portion of the ingot to feed the piping and shrinkage, both of which must occur, as they follow a natural law. Check or hinder ferro-static pressure, and segregation, with its bad effects, at once commences. In the case of "fed" ingots, the smaller amount of segregation which occurs takes place outside the ingot proper; that is, in the head.

The experiment, carried out by the writer some years ago, of pouring copper into the upper portion of an ingot 15 or 20 minutes after casting, showed how serious is this want of ferro-static pressure in the material situated on or near the centre or axis line of the ingot in ingots which have not been properly fed. The copper finds its way down to the bottom of the ingot, although added 15 minutes after casting. In any case, if there is no definite pipe at the bottom portion of such ingot, there is still material of loose or open structure, which means weak steel. Although this may not be apparent by fracture to the naked eye, nevertheless it exists, and can generally be detected by an examination of the microstructure. In other words, notwithstanding that the product to be used may come from the lower half of the ingot, yet in unfed ingots it will be weak and not able to stand severe stresses.

It is true that some portions of the cavities in ingots have been measured, but probably not in the manner described by the writer. Although in the examination of the top of an ingot cast in the ordinary manner and from steel which "settles" there is external evidence of some piping, this is irregular and varies considerably. Therefore, in the "best" ordinary ingot proper evidence is slight as to how much or how little the steel has piped. Dr. Dudley has pointed out that such piping is divided into two kinds: the upper, or what may be termed the visible pipe, and the lower or hidden pipe, the extent and character of which can be determined only by cutting open the ingot. In the ingots cast under the writer's system, all the cavity or pipe is open and can readily be inspected from the top; its extent can be determined whether in the hot or cold condition. It is therefore not necessary to cut open the ingot.

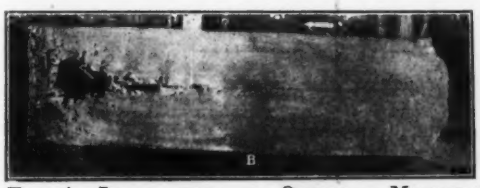


FIG. 4.—INGOT MADE IN ORDINARY MANNER, UNSOUND, WITH BLOWHOLES, PIPING AND SEGREGATION.

Dr. G. K. Burgess, of the Bureau of Standards, Washington, is at present working with the writer on a joint research relating to this subject, and, though the full details of the work done cannot at the present time be given, it may be stated that ingots made under the writer's system were carefully cut up by the Bureau and compared with similar ingots produced at rail mills and made in the ordinary manner. The comparisons are shown in Figs. 3 and 4, in which A (Fig. 3) represents the ingot made under the writer's system, as described in the various papers, and B (Fig. 4) represents an average ingot made by one of the rail-makers.

While it is true that in unsound steel of very mild character the process of forging or rolling closes up the blowholes, and probably, if the heating temperature for rolling or forging is hot enough, the blowholes are welded together, even then it is doubtful whether such material can ever afterwards possess exactly the same tenacity and ductility as the same steel worked up from a sound ingot. In the case, however, of rail steel in which the carbon percentage is high, the same amount of welding does not take place; in fact, it is doubtful whether the blowholes are more than merely pressed together.

As large quantities of high-explosive steel shell are used by various governments, it is most necessary to obtain steel of the highest quality and yet at not too high cost. In other words, there is required steel of superior quality to that ordinarily used for rails, ship and boiler plates, angles, bars, etc. The system of manufacturing ingots of sound steel, described in the present Paper, exactly meets these special requirements. Moreover, it can be used for making the comparatively lower quality of steel referred to. Several important governments, after making exhaustive tests, have been so satisfied with the Hadfield system of making sound ingots that, both for their land and sea services, they have now authorised explosive shell being made from ingots (afterwards forged into necessary billets) produced in the manner described in this Paper.

As will be understood, an explosive shell, whether of small or large calibre, must be absolutely safe; that is, it must be (*a*) sound (that is, free from blowholes); (*b*) free from pipes; (*c*) free from segregation. Any flaw in the shell leading to its premature bursting would be most disastrous. In order to be absolutely certain of obtaining this combination of desirable qualities, it has been insisted upon by the user concerned that something like 40 per cent. to 50 per cent. of the ingot made in the ordinary manner—in fact, sometimes more than this—must be discarded. Ingots made by the writer's method, however, are now allowed after discarding only 15 per cent. It would also be quite possible under the system to give perfectly safe shell with only 10 per cent. to 12 per cent. discard, and to ensure the qualities under the headings (*a*), (*b*) and (*c*) just referred to. This means a reduction in discard from 40 per cent. to 15 per cent. This decision has been arrived at after carefully cutting up and examining over one hundred ingots made by the Hadfield system, produced in the ordinary course of working. Each of these ingots, on being cut up, was found to be perfectly sound.

It should be remembered that steel produced from the ingots to be used fo rthe requirements of various governments is most critically examined by many inspectors supervising the material produced and the

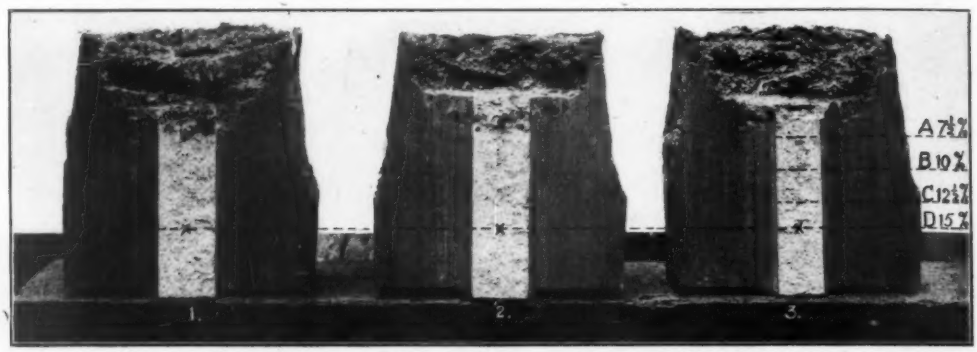


FIG. 5.—UPPER PORTIONS OF THREE INGOTS MADE BY THE HADFIELD PROCESS.

The following is the analysis of the material, taken from the ordinary small sample or test ingot :—

C.	Si.	S.	P.	Mn.
0.38	0.19	0.036	0.031	0.96 per cent.

The following is the analysis on the centre or axis line, as shown by the cross; that is, at the parting line where the 15 per cent. discard was taken :—

C.	Si.	S.	P.	Mn.
0.39	0.19	0.033	0.031	0.96 per cent.

Similar analyses were also obtained from the 12½ per cent. and 10 per cent. discard lines. It was only when the 7½ per cent. discard line was reached (that is, within one or two inches of the top of the ingot) that the analysis showed any change, namely, as follows :—

C.	Si.	S.	P.	Mn.
0.54	0.19	0.056	0.031	0.96 per cent.

After cutting off 10 per cent. discard from the ingot, the whole of the remaining material is : (*a*) absolutely sound; (*b*) free from blowholes; (*c*) free from segregation. That portion of the ingot above the transverse section line *A* represents 7½ per cent discard; *B* represents 10 per cent. discard; *C* represents 12½ per cent. discard; *D* represents 15 per cent. discard.

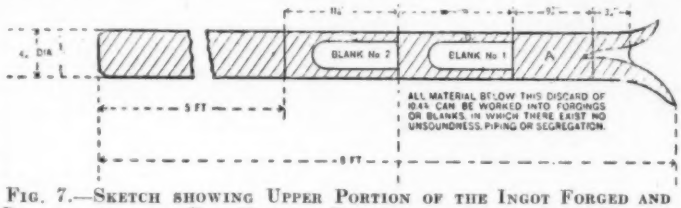

BLANK No 2
BLANK No 1
5 FT
ALL MATERIAL BELOW THIS DISCARD OF 10·4% CAN BE WORKED INTO FORGINGS OR BLANKS, IN WHICH THERE EXIST NO UNSOUNDNESS, PIPING OR SEGREGATION.

FIG. 7.—SKETCH SHOWING UPPER PORTION OF THE INGOT FORGED AND DRAWN OUT INTO A BAR 4¾ IN. IN DIAMETER AND ABOUT 8 FT. IN LENGTH.

It must be borne in mind that this billet is one of several made from the same ingot. In other words, this particular billet represents only the *upper* portion of the ingot. The material below this billet (that is, representing the ordinary or remaining portion of the ingot) is drawn out into the same kind of billets or bars of the same composition as the other billets, and in these, of course, the whole of the material is used.

"C" (No. 2 blank, see Fig. 8) represents the blank made after discarding 10.4 per cent. of the total length of the ingot represented by the portion of the billet "A" and "B."

"B" (No. 1 blank, see Fig. 8) represents the blank made after discarding 7.1 per cent. of the total length of the ingot represented by the portion of the billet "A."

work done, not on the ingot only, but on each projectile, also including a considerable number of mechanical tests from each ingot, and from a certain number of projectiles made from each ingot. Moreover, each individual ingot is cut up and has to be passed on its own discard; if this were not satisfactory the ingot would be rejected.

The following demonstration was made to show the importance and efficiency of the system:—Fig. 5 shows the upper portion of three 15-in. ingots made under the Hadfield system. This plate shows the soundness and freedom from piping of the ingots. If this is compared with the section of the ordinary rail ingot shown in B (Fig. 4), representing average and current practice, it will be seen how great is the difference. While sound material, whether rails or other articles, can be expected from ingots made as shown in Fig. 5, it can be well understood that if steel for explosive shell were made from an ordinary steel ingot cast in the usual manner, as shown in B (Fig. 4), there would have to be at least 50 per cent. discard in the ingot, and even then it is doubtful if the material could be safely used.

FIG. 6.

To further prove this, Fig. 6 shows an etching of the fractured portion of a 15-in. ingot (marked No. 3 in Fig. 5), on the centre or axis line, where segregation is usually met with to the greatest extent. This being so sound and free from segregation, it was necessary to continue the etching beyond the fractured portion. The analysis of this particular 15-in. ingot is shown in Table II. From this table it will be seen that there are no signs of segregation, unsoundness, or piping of any kind until the extraordinarily small discard of 7½ per cent. has been reached. Even in this case the difference in composition is very slight, whereas the composition of an ingot made in the ordinary manner and with only 7½ per cent. discard, to say nothing of the unsoundness, would show probably 0.60 to 0.70 per cent. carbon and 0.07 per cent. each of sulphur and phosphorus.

TABLE II.—*Analysis of the 15-in. Ingot, No. 3 shown in Fig. 5.*

	Analysis.				
	C.	Si.	S.	P.	Mn.
Original steel	0.36	0.19	0.031	0.031	0.96
A. Discard of 7½ per cent. (sand or feeding head of ingot) ..	0.54	—	0.056	0.031	—
B. Discard of 10 per cent. ..	0.46	—	0.040	0.031	—
C. Discard of 12½ per cent. ..	0.39	—	0.040	0.031	—
D. Discard of 15 per cent. ..	0.39	—	0.033	0.031	—
E. Bottom of ingot	0.38	0.19	0.031	0.031	0.96

Table III. shows a number of analyses taken during the ordinary course of working (that is, they are not in any way special) from the centres of different ingots as above described, the drillings for analysis being taken exactly at the parting line where the 15-per cent. discard has been made. The figures obtained clearly show the important fact that the steel is as pure and free from segregation at this part as it is at the bottom or at any other portion of the ingot.

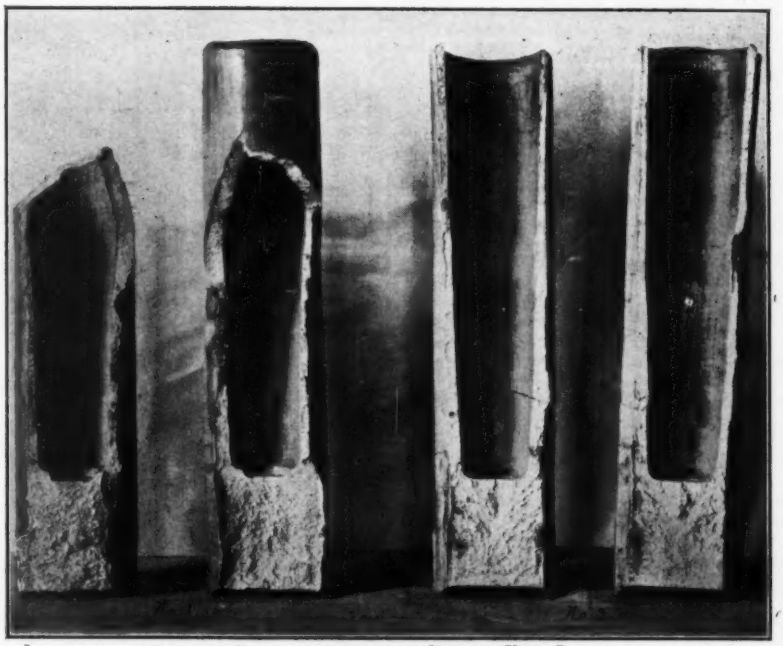


FIG. 8.—BLANKS MADE FROM BAR IN FIG. 7.

As a further test, the following interesting experiment was made:—The portion of one of the ingots representing the usual 40 per cent. of the discard hitherto demanded in the manufacture of high-explosive shell was taken from an 11-in. ingot having the following analysis:—C, 0.38 per cent.; Si., 0.18 per cent.; S, 0.024 per cent.; P, 0.035 per cent.; Mn., 0.85 per cent. This was forged into a bar 4¾ in. in diameter and about 8 ft. in length, as shown by Fig. 7. Projectiles were forged from this bar as indicated.

The length marked A is the portion of the material from the top part of the ingot head which, in the

writer's system, is cast in sand; that is, above the ingot itself. This portion, about 13 in. in length and representing 7.1 per cent. of the discard, was cut off. Below this the projectile forging known as "Blank No. 1," was prepared, as shown by the dotted lines in Fig. 7. Below this, "Blank No. 2" was taken after 10.4 per cent. discard had been allowed. In other words, "Blank No. 1" was made from the material now not used (that is, after 7.1 per cent. of the whole ingot was discarded), and "Blank No. 2" after discarding 10.4 per cent.; this is also not now used. The further and following blanks, Nos. 3, 4, and upwards, are not shown, because this is unnecessary, as such blanks then formed part of the current work. As will be seen, even "Blank No. 2" could also have been safely used.

TABLE III.—*Showing Composition of the Steel made by the Sound Steel System Described in this Paper.*

Table A represents the analyses of drillings from the usual ladle ingot tests. Table B represents the analyses of the same steel, carried out by an independent inspector. The drillings were taken from the centre or axis line of each ingot, exactly on the parting line of the 15 per cent. discard.

Mark.	TABLE A. Analyses made by Hadfield of drillings from the usual ladle ingot tests.					TABLE B. Analyses made by the inspector from drillings taken from the *centre or axis line* of each ingot after cutting off 15 per cent. discard.				
	C.	Si.	S.	P.	Mn.	C.	Si.	S.	P.	Mn.
1229	0.40	0.22	0.030	0.033	0.89	0.37	0.24	0.031	0.035	0.87
1231	0.38	0.21	0.031	0.037	0.88	0.40	0.21	0.029	0.036	0.88
1233	0.40	0.21	0.033	0.035	0.90	0.39	0.20	0.035	0.036	0.88
1234	0.39	0.21	0.032	0.033	0.89	0.39	0.21	0.036	0.038	0.90
1243	0.40	0.26	0.034	0.029	0.91	0.39	0.23	0.026	0.034	0.88
1244	0.38	0.23	0.031	0.032	0.93	0.43	0.22	0.038	0.034	0.86
1245	0.39	0.25	0.030	0.030	0.99	0.38	0.24	0.030	0.032	0.91
1246	0.40	0.21	0.029	0.029	0.95	0.39	0.19	0.025	0.030	0.87
1247	0.37	0.19	0.030	0.032	0.89	0.39	0.18	0.025	0.033	0.86
1248	0.41	0.20	0.026	0.036	0.87	0.45	0.20	0.027	0.029	0.81

It is remarkable to find that the fracture from "Blank No. 1" (that is, at the discard of only 7.1 per cent.) was perfectly sound, free from piping, and showed no signs of segregation. In the interior of the blank, after forging, there were some slight skin cracks proceeding from the hollow portion of the ingot top. The projectile from "Blank No. 2" was perfectly sound in every way, whether as regards surface fracture, freedom from segregation, piping, or any other defects; the interior was also perfectly sound. In other words, from this "Blank No. 2" (that is, with only 10.4 per cent. discard) a perfectly sound projectile was obtained.

The two projectiles from "Blanks Nos. 1 and 2," after being split open, are shown in Fig. 8. It will be seen that the fractures are sound and that in each case, even including the blank from the portion of the ingot with only 7.1 per cent. discard, the material would have etched quite sound and free from segregation. The writer has now produced close upon 40,000 tons of ingots by the plan referred to in this Paper.

Description of Hadfield's Process.

[The following is a description of the author's method of casting steel ingots, castings, etc., which ensures soundness, freedom from piping, and absence of segregation:—The process is illustrated in Fig. 9. As will be seen, it consists in heating the fluid steel in the upper part of the ingot or other mould, and maintaining it in a liquid condition by the combustion, in contact therewith, or in close proximity thereto, during the cooling and shrinkage of the metal in the lower part of the mould, of solid fuel—for example, charcoal—by means of a blast of compressed air which is caused to impinge on the fuel while this is directly or indirectly supported by the metal below; and the interposition of a layer of fusible material, such as cupola slag, which has little or no injurious action on the metal, between the metal and the fuel. This slag largely prevents radiation of heat, the loss of which is much greater than is ordinarily supposed to be the case.]

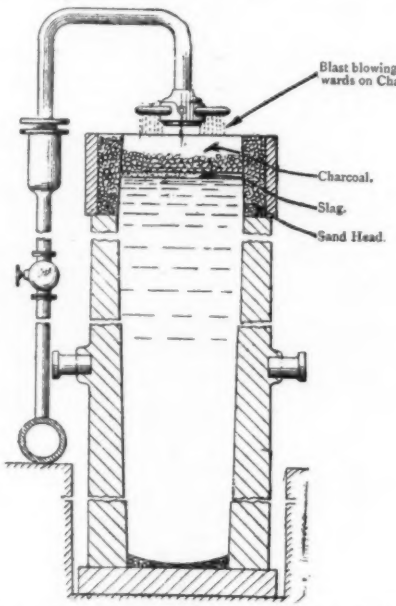


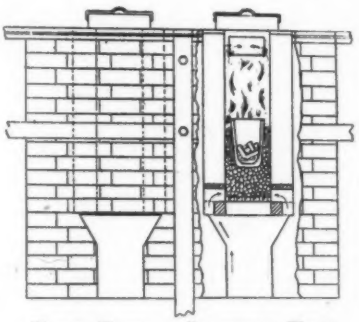
FIG. 9.—APPARATUS EMPLOYED IN PRODUCING SOUND INGOTS, SHOWING THE BLAST BLOWING DOWNWARDS ON THE CHARCOAL.

WELDING MALLEABLE CAST IRON.—A process of welding malleable cast iron evolved by the Vulcan Process Company, of Minneapolis, U.S.A., is based on a welding material which fuses at a lower temperature than the iron. In preparing the work for mending, the fracture is chipped away in the form of a V-groove with the pointed bottom just coming to the surface on the opposite side, or, if the casting is thick and the opposite side accessible, two grooves are cut with their pointed bottoms meeting in the centre. The part surrounding the fracture is then heated with an oxy-acetylene torch to a bright red, and sprinkled with Vulcan bronze flux followed by a few drops of Tobin bronze melted from the welding rod. If the bronze remains in a little globule the work is not hot enough, but if it spreads and adheres to the surface, the temperature is right, and the groove should be quickly filled. It is not advisable to keep the work hot any longer than is necessary, but to make the mend as quickly and at as low a temperature as possible. The behaviour of the bronze affords a guide in regulating the temperature. This process cannot be called autogeneous welding, but a malleable casting mended in this way is claimed to be practically as good as one piece. It has about the same tensile strength and ductility as the original and the process has the advantage of being very quickly performed.

Notes on Copper Alloys and Brassfounding.

By H. L. Reason.

A continuation of two previous Papers on this subject was given at a recent meeting of the Birmingham Branch of the British Foundrymen's Association by Mr. H. L. Reason. The speaker stated that the first thing for consideration in a brass-foundry was the furnace, because badly-designed furnaces and chimney stacks caused endless trouble. To ensure good work, copper alloys must be melted as quickly as possible, care being taken to avoid overheating and burning. Not only did metal deteriorate by being in the furnace too long, but a good deal of undue wear and tear was put upon the crucibles. Furnaces should always be kept in a good state of repair like the cupola. "When a furnace begins to wear and belly out, increased coke has to be used, while another detrimental effect is that instead of having a uniform heat round the pot, the increased coke space makes the bottom of the furnace much hotter and sets up a cutting action on the crucibles." The speaker had seen crucibles ruined after doing five or six heats. The users complained about the quality of the crucible, when the injury was really



FRONT VIEW. SECTIONAL VIEW.

FIG. 1.—BRASS-MELTING FURNACE, PIT TYPE.

due to the intense cutting heat caused by the enlarged furnace. With the brick-built furnace (Fig. 1), if properly designed, there was very little heat radiation, and as men had to work over the top of them that was an important matter in the summer time. Stopping the radiation of heat must lead to more economical melting.

Slides were exhibited showing two furnaces designed by the author, in which the fire bars were made to rest on the bearer, leaving air space between the bottom of the lining and the fire bars. An iron plate with a square hole was introduced to carry the lining, and the furnace was tied together by wrought-iron stays. The height from the pit floor to the underside of the grating should be 5 ft. 6 in. to 6 ft. In a line of furnaces this arrangement would enable a man to walk from end to end, for the purpose of cleaning out, and this could be done without lifting the gratings. In Birmingham the majority of furnaces were built in this way, to stand above the floor level.

Mr. Reason explained that since the last Paper given by him, his opinion on the question as to whether furnaces should be raised or level with the floor had been considerably modified. Before going to Birmingham he had always been used to furnaces level with the floor. "The idea that furnaces should be 10 in. above the floor for pots up to 60 pounds which have to be lifted out by hand was given to me by an expert furnaceman, who demonstrated that placing the shin against the front of the furnace steadied the body, and enabled the man to apply more strength when lifting the pot out; but he happened to be a strong, powerful man about 5 ft. 10 in. I find the average height of workmen engaged on this work is much below this, and in consequence it is necessary to stand over the furnace when lifting the pot out. This has convinced me that the top of furnaces should be level with the ground."

Coming next to deal with more modern methods of melting metals, the speaker exhibited a series of views of high-pressure-gas furnaces of various types. It was explained that several brass foundries in Birmingham had adopted such furnaces, and for the supply of these the Corporation Gas Department had twenty miles of high-pressure gas mains laid. The advantages of such furnaces over coke furnaces are that the metal is melted in a reducing atmosphere, and is not subjected to the sulphur fumes of the coke, while less oxidation takes place, the foundry is cleaner, and there is no trouble of carting away coke and ashes. The only disadvantage is that such furnaces are very noisy.

Fig. 2 shows a sectional elevation of a high-pressure-gas furnace in position. The crucible is placed on a pedestal so as not to come into direct contact with

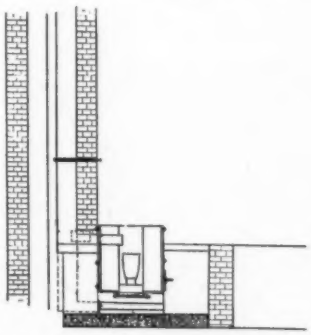


FIG. 2.—SECTIONAL ELEVATION OF 70-LB. HIGH-PRESSURE-GAS FURNACE.

the flame from the burner. In this type of burner a damper is necessary for regulation according to the climatic conditions. By the careful use of this the highest efficiency can be secured. The burners require no adjustment after being regulated and fixed.

Calling attention to Mayer's reverberatory furnace, the author explained that where large quantities of metal were required, air or reverberatory furnaces were employed. The fuel for such furnaces was hard coal, using about one-half cwt. per cwt. of metal melted. The capacity of the furnace was 3½ cwts., and it was possible to melt six or more heats per day. Such a furnace would work six months in constant use without being re-built.

The following table showed the approximate cost of fuel for different types of furnaces:—

TABLE I.—*Approximate Cost of Fuel for Different Types of Furnaces.*

No.	Type of furnace.	Size.	Class of fuel.	Quantity of fuel per cwt. of metal melted.	Remarks.
1	Reverberatory.	¾ cwt. to 2 cwt. 2 ton to 20 ton.	Coal.	84 lbs.	In small furnaces which can be worked continually, the coal consumed is reduced about one third.
2	Pit lift out crucible.	300 lbs.	Hard coke.	28 lbs.	Time melting, 45 to 60 minutes.
3	Pit lift out crucible.	300 lbs.	Gas coke.	36 lbs. to 42 lbs.	In small furnaces 60 lbs. and under the difference between hard and gas coke is not so marked.
4	Coke tilting furnace.	400 lbs.	Hard coke.	24 lbs.	Blast pressure 1½ to 2" water-gauge.
5	Oil tilting crucible furnace.	400 lbs.	Crude creosote or tar oil.	1¼ galls.	Blast pressure from ½ lb. to 25 lbs. according to type of furnace and burner.
6	Oil tilting furnace without crucible.	400 lbs.	Crude creosote or tar oil.	2½ galls.	
7	High-pressure-gas crucible furnace.	60 lbs.	High-pressure gas.	250 c.ft. per hour.	Pressure, 12 lbs. per sq. inch. High-pressure gas 1s. 3d. per 1,000 c. ft. Time melting 60 lbs. 50 minutes.

Total cost of compressing the ordinary town gas to 12 lbs. per sq. inch, including interest and depreciation on plant, labour and power, should not amount to more than 2d. per thousand cubic feet of gas compressed and delivered.

With regard to the speed of melting, this in properly-designed furnaces should be from 40 to 45 minutes for any size of pot up to one capable of containing 250 pounds.

The author proceeded to deal in detail with the subject of copper alloys, remarking that those engaged in the brass foundry were differently placed to workers in the iron foundry. The modern foundry chemist would say that it was a fallacy to describe the irons of 50 to 100 years ago as very much better than those of to-day, and he would further assure them that with the knowledge of the analyses and of the physical properties of the various brands of iron, it was possible by skilful mixing to produce an iron to meet any requirements, so that instead of buying expensive brands of iron, cheap brands could be mixed in such a way as to produce the same result.

Nothing like that could be said with regard to brasses and bronzes, which were in a very different position, because the basis metal must be copper. In brass foundries generally only one brand was used, which was known as "best selected"; there were no grades in copper as in pig-iron, and the market price was the same the world over. The various alloys were made by the addition of tin, zinc, lead, etc., and no amount of juggling would make any difference. In other words, every alteration of mixture might be depended upon to produce some difference in the metal alloy.

The difficulty that confronted one when called upon to make copper alloys was the limited amount of data available to assist in arriving at what was the best and most economical alloy to use for the work in hand. Text books gave a bewildering number of different alloys for the same class of work. Instead of various mixtures being given in percentages they were invariably given in parts, and before being able to understand them properly it was necessary to change the parts into percentages. In brass foundries generally the mixtures were made up by parts, and, in the event of anything going wrong, or the alloy requiring alteration, the mixture was altered, some fractures were examined, and castings machined and tested without any attempt to ascertain the actual composition.

The speaker said he would advise anyone still working on that principle to cease doing so, and ascertain the mixtures by percentages. Every mixture had its own properties, and a difference of merely 1 per cent. would often effect a very marked change in the result. This was really the only way to properly regulate mixtures, and would make the work of costing much easier. The making of copper alloys was not so difficult as would at first appear. To begin with, in gunmetal or bronzes the copper only ranged between 83 and 88 per cent., and in brasses from 60 to 70 per cent.

Discussing the copper-zinc series, the speaker remarked that as the zinc was increased the tensile increased until 45 per cent. was reached. The elongation, however, commenced to fall rapidly. The crossing point of the lines on the diagram indicated a mixture of 60 copper and 40 zinc, the universal mixture for cast brass. Attention was also called to the fact that the greatest elongation was secured by a mixture of 70 copper and 30 zinc, an alloy giving the greatest stretching properties. That explained why the alloy was used for drawing brass tubes and rolling into sheets.

Coming next to the copper-tin series, Mr. Reason pointed out that the highest tensile strength was obtained with 17½ per cent. tin. The elongation, however, fell rapidly before 10 per cent. was reached. Foundrymen were not interested in mixtures beyond 10 per cent. tin.

Special attention was called to the properties of standard gunmetal, consisting of 88 copper, 10 tin, and 2 zinc. That mixture gave the highest tensile strength with a corresponding good elongation. Anyone who had machined that alloy could testify to its toughness. He had experimented with copper-tin-zinc alloys, and was agreeably surprised to find that the strongest alloy contained only five per cent. of tin (see Table II.). The difference in the cost of the two metals was as between £80 10s. 5d. and £85 5s. 10d.

TABLE II.—*Copper-Tin-Zinc and Copper-Tin Series.*

No.	CU.	SN.	ZN.	Tensile tons per per sq. inch.	Elongation per cent. on 2 inch.	Cost per ton.
1	85	1	14	13.1	32	£60 5 0
2	85	2.5	12.5	12.6	28	£62 5 0
3	85	5	10	15.1	25	£65 5 0
4	85	7.5	7.5	13.2	25	£68 5 0
5	85	10	5	9.7	25	£71 15 0

Copper Tin.

6	99	1	—	13.3	28	£65 5 0
7	97.5	2.5	—	11.3	26	£66 0 0
8	95	5	—	14.6	25	£69 5 0
9	92.5	7.5	—	13.8	20	£71 5 0
10	90	10	—	12.1	15	£73 12 6

Copper, £65. Zinc, £25. Tin, £152. Lead, £18 10s.

Table III. was exhibited showing the grading of gunmetals:—

TABLE III.—*Bronzes.*

No.	CU.	SN.	ZN.	PB.	P.	Tensile tons per sq. inch.	Elongation per cent. on 2 inch.	Cost per ton.
1	88	10	2	—	0.5	18 to 20	15 to 20	£74 13 4
2	88	10	2	—	—	16 to 18	10 to 15	£72 6 8
3	86	10	2	2	—	14 to 16	—	£71 15 0
4	85	10	5	—	—	9.7	25	£71 3 4
5	85	7.5	7.5	—	—	13.2	25	£68 5 0
6	85	5	10	—	—	15.1	25	£65 5 0
7	85	5	8	2	—	13	16	£65 2 6
8	85	2.5	12.5	—	—	12.6	28	£62 5 0
9	85	1	14	—	—	13.1	32	£60 5 0

Brasses.

10	60	40	—	—	—	25	47	£49
11	65	35	—	—	—	22.5	52.5	£52 3 4
12	70	30	—	—	—	20	57.5	£53 3 0

Copper, £65. Zinc, £25. Tin, £152. Lead, £18 10s.

The first alloy the author described as having 0.5 per cent. phosphorus and being a good metal for steam fittings that had to be subjected to hard wear. No. 2 was the Admiralty gunmetal universally used in all best work and eminently suitable for steam fittings and brasses required to stand heavy crushing loads. No. 3 was an alloy similar to No. 2, but with 2 per cent. of lead added, to assist machining. This was described as a first-class mixture well adapted to meet all general requirements. In Nos. 4 to 9 the percentage of copper was the same. Below 85 per cent. copper the metal lost its gunmetal colour and had the appearance of brass. Unless gunmetal, brass, and lavatory fittings had a good red colour customers often objected to them.

The author called attention to the remarkable economies possible by the selection of suitable metals. For example, if No. 6 alloy was suitable for a certain class of work and an alloy of the composition of No. 2 was used, there was a waste of £7 1s. 8d. per ton. So that if 20 tons of castings were turned out per week the value wasted would be £141 13s. 4d. In the case of No. 7, an alloy similar to No. 6, but with an addition of 2 per cent. of lead, the result of the addition was to bring down both the tensile and the elongation. No. 10 was described as the universal alloy for cast brass. In this case the addition of 2 or 3 per cent. of lead made the alloy 60—38—2. This was a metal very suitable for fittings having to stand hydraulic pressure. The alloy No. 11 was described as very ductile metal, suitable for castings requiring to be brazed. No. 12 was an alloy used in the rolling mills for brass tube and sheet, and was also suitable for castings requiring to be bent and brazed.

The author remarked that while he had demonstrated that copper-tin-zinc alloys could be made to compare favourably with copper-tin alloys, so far as tensile strength and elongation were concerned, there would be a considerable difference in the hardness and wearing properties of No. 5 and No. 9, more especially in the case of a fitting similar to a steam cock that had to withstand heat and keep a good bearing surface. In that case No. 9 would be far superior.

When making copper alloys for various classes of work, besides knowing the tensile strength and elongation of the different mixtures, it was necessary to know the hardness properties. It was clear from Table IV. that there was a graduated scale of hardness, commencing with manganese-bronze. Phosphor-

TABLE IV.—*Copper Alloys. Hardness Numerals obtained, 500 kilogram=9.83cwts. Pressure, 10-millimetre Ball applied for 30 seconds.*

	How cast.	
	Sand.	Chill.
Manganese bronze	109	119
Phosphor bronze, Cu. 80, Sn. 20	158	—
Phosphor bronze, Cu. 90, Sn. 10	86	—
Gun metal, Cu. 88, Sn. 10, Zn. 2..	70	86
Phosphor bronze, Cu. 80, Sn. 10, Pb. 10 ..	50	80
Gun-metal, Cu. 85, Sn. 5, Pb. 5, Zn. 5	48–59	—
Yellow brass, Cu. 69, Sn. 1, Zn. 30	54–59	—
White brass, Sn. 66.5, ZN. 29, Cu. 4.5	19–20	—
S.A.E. Babbitt, Sn. 84, Sb. 9, Cu. 7	—	25-30

bronze having 20 per cent. tin was twice as hard as one containing 10 per cent. Comparing phosphor-bronze containing 10 per cent. with standard metal, which was practically the same mixture, the effect of phosphorus had been to put the numeral up from 70 to 86. Comparing the next phosphor-bronze having 10 per cent. lead with the next gunmetal containing only 5 per cent. tin and having the lead reduced to 5 per cent., it would be seen that the hardness numeral was slightly higher in the gunmetal. The author also called attention to the fact that the yellow brass containing 69 per cent. copper, 1 per cent. tin, and 30 per cent. zinc was harder than the last two alloys. It would be noticed that the effect of chilling was to increase the hardness.

Some interesting diagrams were exhibited illustrating the colour effect of various changes in the composition of copper-zinc alloys ranging between pure copper and pure zinc. The plan was to add 10 per cent. zinc to each alloy, commencing at No. 9, which represented the colour of gunmetal. The colour of No. 5, which comprised copper and zinc in equal proportions, was similar to No. 9, or gunmetal colour. The chart, Mr. Reason remarked, had cleared up what had been to him a problem for a long time. Most of them were conversant with high-speed turning brass used on capstan lathes, and had noticed its gunmetal colour. Knowing its analysis, he could not understand why an alloy between No. 5 and No. 6 type should be as red as an alloy containing 90 per cent. copper. He considered that this explained the phenomenon, and he concluded that the extrusion process had affected the colour. No. 4 was a metal too hard and brittle to work. It contained 60 per cent. zinc, and might be described as having reached the rotten stage. In No. 5 they had 50 per cent. zinc, and it was evident that at this

stage the zinc produced the gunmetal-colouring effect on the copper. That explained why the extruded rods, being an alloy between the 5 and 6 type, had a gunmetal colour.

A further series of colour-effect bronzes consisted of 11 specimens, intended to show the effect on the colour of varying the proportions of tin, zinc and lead. The author concluded that it was impossible to tell a good gunmetal by the colour. In the zinc series No. 4 was standard gunmetal colour. No. 3 was paler, while No. 2 had quite a yellow tinge.

In the tin series, commencing with No. 8, which was of standard gunmetal colour, it was noticeable that the increased percentage of tin in No. 6 had not affected the colour very much. The two most interesting alloys in those two series were No. 5 and No. 8. Although both contained the same percentage of copper, No. 5 was slightly deeper in colour. Nos. 9, 10 and 11 exhibited the colouring effect of lead. They all contained 85 per cent. copper. But No. 9, with 5 per cent. lead, was slightly deeper than standard gunmetal, while No. 10 was still deeper, and No. 11 was copper colour. That slide, said Mr. Reason, showed how easily one could be deceived in bronzes when judging by the colour only.

The question of the amount of lead in bronzes always created a good deal of interest. It could be used up to 3 per cent. in most mixtures with advantage. The addition of lead made the metal easier for machining. A skilful furnaceman could produce good gunmetal castings with an alloy containing 5 or 7 per cent. lead. But great care had to be taken that the metal was not overheated, and the castings must be poured at the right temperature. If the castings were on the heavy side and the metal was poured too hot, the lead would be forced to the outside in the cooling process. "In the brass hollow-ware trade high-lead alloys are used. This is possible because owing to the thinness of the castings the metals sets very quickly, the lead is trapped, and does not get the chance to ooze out. The effect is almost the same as that of pouring metal into a chill." A good common brass for thin castings not required to withstand hydraulic pressure consisted of copper 52 per cent., zinc 41.5 per cent., lead 6 per cent., aluminium 0.5 per cent.

The following is the composition of a high lead alloy or nickel bronze:—Copper 83 per cent., tin 5 per cent., zinc 5 per cent., lead 5 per cent., nickel 2 per cent. This, said the lecturer, proved a better alloy for hydraulic castings having to stand 3,000 pounds' pressure than the well-known composition 88—10—2. Although this alloy did not give high tensile, it had the necessary closeness of grain to withstand the pressure. The difficulties of segregation in an alloy containing 5 per cent. lead were overcome by the introduction of 2 per cent. nickel. The high freezing point of the nickel trapped the lead, prevented it from oozing out, and made a close-grained alloy; it was the nickel that produced the good qualities for hydraulic work.

Owing to the high prices of tin, antimony, which was cheaper, could be partially substituted, but it did not have the same hardening effect on copper as tin. The success of antimonial mixtures depended a good deal on the furnaceman. The following mixture cast well and machined satisfactorily:—Copper 83 per cent., zinc 10.5 per cent., tin 2.5, lead 2.5, antimony 1.5.

Fluxes were not used to a very large extent in brass foundries; it all depended on the class of metal used. For yellow brass with large percentages of scrap, ordinary common washing soda was very beneficial. For bronzes, phosphorus was the best flux. In the case of castings that were difficult to make sound, owing to shape or unequal thickness, a small addition of phosphorus was a decided help. It gave a fine-grained and non-porous casting. The best way to add phosphorus was in the form of phosphor-copper or phosphor-tin.

Discussion.

Mr. T. G. Dobson said he had obtained very good results from pit furnaces. The best were got from two Bickford oil furnaces, in which he was able to pass the heat from one chamber to another. He was able to bring out a heat of molten metal with a 120-pound crucible every fifteen minutes. That was solely because the heating went on simultaneously. He attached to those furnaces drop-bottoms, which enabled him to take the bottom further down and place a stand on it for the crucible so that the pressure of the air did not interfere with the crucible. He had been able to get an average of 27 heats from the crucibles used in those furnaces. He had also used the Schwartz oil furnace for melting brass boring and small scrap into ingots, and had melted an average of 9 cwts. per hour using continuous heat. He had succeeded in obtaining 10 to 12 heats a day out of that furnace. With regard to air furnaces, it was possible to deal with a good weight of brass metal, but the essential point was to keep it heated up and in operation for a whole week day and night. Repeated heating up made the operation very expensive, and a peculiar feature of air furnaces used for brass was that they seemed to eat up or absorb the metal in the bottom. When the time came to repair those furnaces there had sometimes been taken out skulls or metal absorbed in the bottom weighing between one and two tons. His own experience was that he could never get a good tight hydraulic gunmetal out of an air furnace. He considered that nickel was detrimental to gunmetal.

Mr. C. B. Roe said it was common practice with a raised furnace for the furnaceman to put core stocks round the top of the furnace to get them heated and dried. But in Mr. Reason's furnace he did not notice any oven at the top of the furnace for the heating of the stocks. Was a separate oven employed for that purpose? As to phosphorus, he would like to know what was considered a proper amount to add to a 60-pound pot. Undoubtedly, the presence of iron in the scrap accounted for a great many of the troubles which some people had with their metal. Recently, he knew of a case of a three-inch main cock which had to be bored, and in the centre of the metal was found a lump of iron, which destroyed the tool. With regard to the judging of qualities, he had always been taught to judge metal by fracture, and it was commonly supposed that decent copper could be identified when it came to be broken. Of course, the determining of the quality only came through experience, but there was no doubt in his mind that one could just as well test the quality of copper, as of zinc by fracture. Certainly, by careful examination, it was possible to determine its quality sufficiently for practical purposes.

Mr. F. Johnson said the last speaker spoke very confidently as to the possibility of determining the quality of copper by fracture. On that point he (Mr. Johnson) was able to speak as a practical copper refiner. He could give the last speaker a piece of copper which he was quite sure he (Mr. Roe) would pass as good, but which, when mixed with zinc, would make a useless alloy. Mr. Reason erred a little in the same direction when he said that there was only one brand of copper for making an alloy, namely, B.S. B.S. would be all right if there *were* only one brand. But in practice they knew that there were a great many varieties, and, in fact, it was possible to get all sorts of B.S. copper. He had made experiments

with antimony in copper, as well as with arsenic, for the purpose of ascertaining what was the influence of those elements on copper-zinc alloys, and he found that with only 1-300th part present of each element it was possible to produce brass as brittle as a carrot. Mr. Reason had dealt to a great extent with copper-tin-zinc alloys. But apparently a word of caution was needed in connection with the influence of tin on brass. If to a certain brass of a composition between 70 per cent. and 60 per cent. of copper tin were added, the tensile strength and the elongation would be considerably reduced; in fact, a matter of less than ½ per cent. of tin would ruin what was known as common rolling brass. Considerably less than ½ per cent. of tin would spoil the alloy when the alpha constituent was saturated with zinc. The addition of tin to such an alloy produced a second constituent which the first constituent was incapable of holding in solid solution. In a brass of 70-30 composition there was one constituent and no brittle constituent coming out. When tin was added, a tin-rich eutectoid was got which was a highly-brittle constituent, and he thought Mr. Reason would be very easily able to prove for himself that that eutectoid was detrimental to the properties of the brass. Attention to the micro-structure would have thrown light on the colour of the brasses containing between 50 per cent. and 60 per cent. of copper. He had already referred to brass containing 70 per cent. of copper and 30 per cent. of zinc as having one constituent. But in those 60 per cent. to 50 per cent. of copper a second constituent was obtained. The first constituent was alpha, and the second was beta. The alpha was yellow, and therefore that would account for the yellow colour. The beta constituent was reddish or bronze-coloured, and that certainly gave the bronzy appearance to the high zinc alloys or those containing between 60 per cent. and 50 per cent. of copper. He had recently had some experience in the making of castings required to meet a certain specification. The object was to produce in a chilled casting properties equal or nearly equal to the properties of a drawn or rolled bar. It was not an easy proposition. But he was able to produce that alloy, and he rather thought that there was a great future for the chilled casting of special brass coming up to those requirements. In that connection he thought it would be found that the addition of such metals as manganese, iron and aluminium in judicious proportions might be very beneficial. With regard to the use of deoxidisers, he would like to know what the lecturer's experience had been in regard to the influence of aluminium on brass. His own experience had been that it had a very beneficial influence, but he found also that it had a decidedly detrimental influence. In making chilled castings the oxide film produced by aluminium on the surface of the molten metal was very difficult to get rid of. It was very difficult to make a casting having its surface free from that tenacious oxide. The other disadvantage was that it increased largely the fluid shrinkage of the brass. On the other hand, a decided advantage was that the metal was more fluid, and it was possible to see very much more clearly the molten contents in the crucible. As they were all aware, the volatilisation point of zinc was very low, and instead of the fumes coming off and obscuring the surface, the addition of aluminium got rid of that trouble entirely, and it was possible to see the surface of the metal quite easily. He wished to add one word with regard to the manufacture of die castings. He had seen a small die casting in brass of ordinary composition which was perfect. The article was cast in a very intricate shape with many corners and curves, and was, in parts, only about one-eighth of an inch thick, and yet it was quite sound and smooth. He believed that there was an enormous future for the industrial manufacture of die castings in brass, and he thought all those interested in brass casting would do well to turn their attention to the process.

Mr. Harley said that there were, as Mr. Johnson had pointed out, a great many makes of "best selected" copper, and he had found it necessary in buying copper to specify a number of standard makes from either of which the merchant could make a delivery. In this way, and by careful inspection on receipt, with an occasional analysis, one might be assured of a raw metal of consistently good quality. He could also confirm what Mr. Johnson said about die casting, but pointed out that previous to embarking upon this method of production it was necessary to be sure of large repetition orders. There was no doubt, however, that with increasing standardisation of parts die casting had an increasingly important part to play in foundry production. At the present time he was rather in favour of the oil tilting furnace, which was very reasonable in the matter of cost. He was firmly convinced that electrical melting could be applied not only to steel but to many other metals, such as some copper alloys, or even cast iron which had to meet special specification.

Mr. Reason, replying to the discussion, said that with regard to Mr. Dobson's ability to get 120 lbs. of metal out of his furnace in 15 minutes, they had, of course, to consider the real question of how long the metal had been in the furnace.

Mr. Dobson remarked that he got out four heats in two hours, which was an average of half an hour per heat, and that was managed because the furnace was never allowed to get cool.

Mr. Reason, continuing, said that no doubt the low oil consumption referred to by Mr. Dobson was due to the fact that he was heating up the metal to begin with and making the fullest use of the heat. As to the difficulty of getting satisfactory hydraulic castings from the air furnace, he (Mr. Reason) had not had practical experience with an air furnace. But that was exactly the trouble he would expect, because there would naturally be a tremendous amount of air blown in, and consequently an equivalent oxidation, and unless the alloy was treated with charcoal, oxidation would give trouble, and there would be difficulty in getting sound castings. It was quite as easy to deal with mixtures in percentages as parts if the mixtures were made up in lots of 100 lbs. As to core drying in connection with the furnace, he considered the core-drying stove should be quite separate from the furnace. The stove should be properly designed and quite apart. Generally in large foundries the drying of cores was done in ovens in the core-making department, which was separate from the foundry. With regard to the amount of phosphorus, this should not be more than 0.5 per cent., and by purchasing phosphor-copper containing from 10 to 15 per cent. of phosphorus it was possible to regulate so that no more than 0.5 was in the mixture. No doubt a good deal of the trouble in the brass foundry would be avoided if they could be quite sure that the copper was right. The addition of tin to ordinary brass, either of 70: 30 or 60: 40 had a wonderful effect of increasing the tensile strength, and he would like to say that they in the brass foundry world would very much appreciate something being done in the direction of showing the physical properties of brasses and bronzes and the effect of adding tin and lead. In regard to the question of the effect of aluminium on brass, he had not used aluminium alloys to any extent, but where brass castings of an ornamental or intricate nature were required alu-

minium was distinctly helpful in obtaining sharp castings. But for ordinary brass castings that had to stand hydraulic pressure aluminium was detrimental. As to the electric belting, he believed that a lot of the brass-foundry troubles would be overcome if it was possible to melt their metal in an electric furnace.

Discussion at Halifax Branch.

Before a recent meeting of the Halifax Branch of the Association, the same address was delivered.

Mr. Campbell remarked that the lecturer had said many things in favour of tilting furnaces, but the economy shown was somewhat false. On account of the crucible he condemned the tilting furnace. £2 15s. could be spent on a crucible which might go wrong in the first heat. Some would last 10 to 12 months, but it was very tantalising to have an expensive article give way. At his works they had reverted in some alterations they were making at the present moment to what they might term the old-fashioned furnace—level with the floor. A medium size crucible was used, and for heavy castings Mayer's reverberatory furnace with natural draught was used.

Mr. C. L. Simpson said that some years ago when Jas. Simpson & Company, Limited, of London, moved their works to Newark-on-Trent, after close investigation they adopted the tilting furnace and brought a couple of them over from Switzerland. Unless great care was taken in the treatment of the crucibles and the working of the furnace, they could not get the crucibles to stand the proper number of heats. The form of furnace for use in a brass foundry very much depended on what class of work had to be dealt with, and also the class of labour employed. Mr. Reason had not mentioned anything about the education of the furnaceman or the man who had control of the castings in the brass foundry. It was essential that the men who carried out the work of melting should be carefully trained, as when troubles arose it was very difficult to locate exactly the cause. Without doubt it was a good thing to consult a chemist as regards what was contained in different alloys. Regarding the melting of metals with high-pressure gas, even if the cost of the gas worked out higher as compared with coke, there were certainly other advantages which had to be considered when comparing the various methods of melting. When coke was used, one had to be very careful to get the best possible coke, and one low in sulphur.

Mr. Derrington (Messrs. Ed. Foster & Sons, Limited) said that oxidation of copper was a trouble they all had to face. He thought oxide of copper could not be reduced in the crucible after it had been formed. The furnaceman ought to be better educated on this point. He it was who let the oxide form, and then by throwing a handful of charcoal upon the metal thought he had put it right. If charcoal did not cover the copper to prevent the oxide, it would not be reduced. He agreed that phosphorus was a good flux; he had found it the best flux. He thought Mr. Campbell had been unfortunate in regard to tilting furnaces. They ran two at their works, and at first had had endless trouble; but the only trouble now was that when the furnaceman became experienced he left, and another man had to be trained. They used the M.R.V. furnace, and could generally get 30 to 40 heats with the pots. All depended upon the furnaceman. The biggest trouble was in lighting the fires. If they commenced with a coke fire it only got lit half way round the crucible, with the result of unequal expansion and a cracked pot. If they lit with a coal fire, a bright fire was got all round the bottom, and equal expansion of the pot.

Mr. Pemberton said he had prepared a small experiment to show the oxide of copper as it was formed on a piece of copper plate. A piece of copper plate was rinsed with salt and water, then heated to almost a red heat, when it showed the oxide of copper formed. This oxide of copper, when it got into the alloy was very difficult to remove, as the density of the oxide and the density of the copper were very much the same. Mr. Reason had spoken about the burning of brass and bronze. He rather took exception to the word burning. He thought it was oxidation of the metal. As to overheating of metal, that was a different thing altogether to burning metal. If metal was allowed to remain in the furnace after a certain length of time, it absorbed gases which were not given off when the metal was cast. In 99 per cent. of cases pinholes in castings were due to overheating the metal in the furnace. As to the care of a pot, before being put into the fire it should be annealed, if possible for two or three days, to get all the moisture out of it. An excess of fuel should be used, and a reducing atmosphere produced. This would cause the pot to create a slag upon itself which formed a protection. An oxidising flame in the furnace attacked the pot, which was partly of carbon, and left porous places. With regard to high-pressure gas furnaces, some time ago he experimented with the ordinary pit-fire furnace and high-pressure gas. The alloy consisted of 80 per cent. copper and 20 per cent. zinc. In the pit furnace the time taken to melt the metal was 66 minutes; the initial weight was 100 lbs., and the total net weight received in the ingots was 99 lbs. 7½ ozs., the loss of weight being 0.53 per cent. In the high-pressure-gas furnace, the initial weight was 99 lbs. 12 ozs., and the net weight received in the ingots after melting was 98 lbs. 12 ozs., showing a loss of 1.02 per cent. The time taken to melt the metal was 74 min. 40 sec.; the average pressure of gas was 22.8 in. mercury, and the consumption was 875.2 cubic feet, the cost at the rate of 1s. 3¾d. per 1,000 ft. being 10.47d. The total weight of coke consumed in the pit fire furnace was 44 lbs. at a cost of 3.35d. for fuel, against 10.47d. The cost of the crucible with an average life of 26 heats per pot was in the coke furnace 6.1d. against 7d. in the high-pressure gas; the total cost of metal was 1.42d. against 1.78d., which showed that cost per ton was £1 10s. 3d. in the coke furnace against £2 4s. 6¼d. in the high-pressure gas—a difference of 47 per cent. Mr. Reason had said that the time for melting in the oil-fired tilting furnace for any size up to 250 lbs. was from 40 to 45 minutes. He (Mr. Pemberton) found the time taken to melt 600 lbs. in an oil furnace was one hour twenty minutes.

Mr. H. L. Reason, in replying, said, with reference to tilting furnaces, these could be used satisfactorily for heavy gunmetal work or running down large quantities of scrap metals, but they were not so suitable for small thin work that must be poured hot, owing to the loss of heat in transferring metal from the furnace to the ladle before pouring. As to the difference in cost between high-pressure gas coke, although the cost of gas came out higher than coke, this was counterbalanced by the reduced losses in melting. In the coke furnace the average loss with brass was about 5 per cent., this being reduced in the high-pressure gas furnace to 2 per cent.; and carting of ashes and coke was done away with. As to the toughness of the 88 copper, 10 tin, 2 zinc alloy, he did not know how this could be altered without affecting the tensile strength and elongation. He had been asked why the high-speed turning brass as used on capstan lathes turned yellow when heated. This was only a surface effect, similar to that obtained when tempering steel.

Core Boxes and Core-Making.

By D. Gordon, A.M.I.Mar.E.

(*Continued from page* 255.)

When cores of a similar character are required to be formed by means of a guide and strickle, they may be made in either dry-sand or loam. When the former are required, they are made up or "strickled" to shape whilst the sand is in its green state, being afterwards dried. This necessitates, in most cases, a sand bed to support them during the drying period; or alternatively, the plate upon which they are "struck up" must act as the means of support. Only when strong bearing irons or grids are used can these two methods be obviated with any degree of safety in handling.

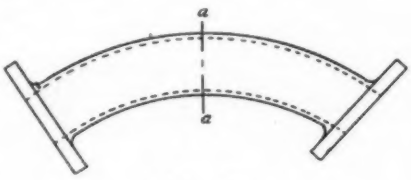


Fig. 81.

Section *a a*

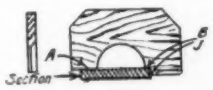


Fig. 84.

If loam is adopted for making the cores, they are "strickled" to shape in the same manner as those made by the dry-sand method, the consistency of the material being the same for loam moulding, excepting that the clay content in the latter case is slightly lessened to increase the porosity of the material, and its removal from the casting is also more easily performed.

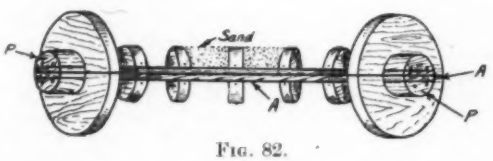


Fig. 82.

In many cases cores that are "strickled" to shape are used in conjunction with skeleton patterns, and if these latter are constructed with central joint plates—which embody the full sectional width of the casting—one of these is used as a pattern for the core's guide plate. If, on the contrary, this method is not permissible or convenient, it then follows that a special pattern is necessary if an iron guide and support plate is to be used; and as these plates are cast up in open sand no special finish, beyond the accuracy of curvature, is required for the pattern.

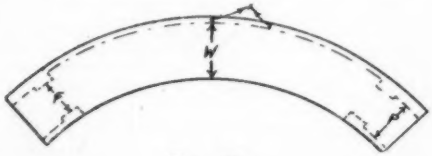


Fig. 83.

As for the castings, it is necessary that their surfaces should be in true alignment, but inequality of thickness and surface roughness are matters of little consequence, as will be readily understood later.

Only in exceptional cases are wood guides and support plates utilised, and then only if the core is to be in dry sand, as the absorption of moisture by wood produces distortion which reacts upon the core. When wood support plates are used, a sand bed for supporting purposes during the drying period is imperative, as the heat and moisture would distort the plate to the detriment of the core; also, as this type of core is invariably made in halves, a level joint is essential.

Instead of having the guide plates to also act as a means of support for the cores, they are commonly used for guide purposes only. In such cases, they can conveniently be formed of wood, but if the number warrants its adoption an iron bar bent to the required curvature is preferable, as it allows no possibility of distortion and can be used in conjunction with either dry sand or loam. When plates or bars act as guides only—as distinct from guide and support plates—the cores struck up by their means are, as a rule, made direct upon the stove plate which supports them whilst drying.

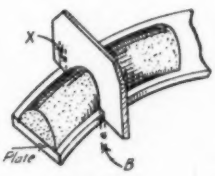


Fig. 85.

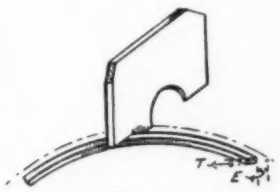


Fig. 86.

To explain more fully these differing methods, which differ only in applicability and not in principle, the core required for the common type of bend-pipe (Fig. 81) affords an excellent example. Assuming a skeleton pattern, Fig. 82, is to be used, and one central joint plate of which is to be utilised as the pattern for a guide and support plate, this plate previous to its completion as part of the pattern mould should be made as shown in Fig. 83. In its length it extends to the print's extremities (*P P*, Fig. 82), and in its width exceeds the pipe's diameter. With reference to this latter, if the metal thickness is less than ¼ in., this width must be extended so that sufficient bearing surface may be obtained for the strickle. The amount of bearing usually allowed varies between ¼ and 1 in., but in no case should

it be less, and consequently the joint plate of the pattern is initially made larger to allow for this.

In Fig. 83 the marked-out pattern plate for a pipe of ½ in. or greater metal thickness is shown, the width *W* being the complete pipe's diameter, the amount in excess at *X* being the bearing allowance for the strickle. *P* denotes the print diameter and *F* the amount to be recessed for attaching the pattern flanges. The form of strickle used in conjunction with a guide and support plate is made as shown in Fig. 84, its bearing surface at *B* being equal in length to the metal thickness plus the amount allowed.

That portion of the strickle which strikes up the core is bevelled upon its edge, so that regularity of contour combined with freedom in its use is obtained.

If the core is to be in loam, two plates are required (to carry the respective half cores), but if in dry sand one plate only is necessary, and the core is made by packing the sand or loam upon the plate's surface,

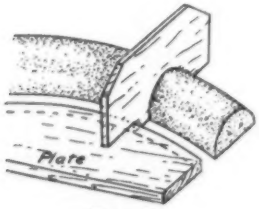


FIG. 87.

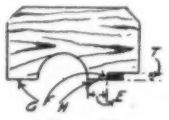


FIG. 88.

the strickle then being worked along the edge, thus sweeping the sand to the conformity of its strickling edge. When only one plate is used it follows that to obtain the corresponding half to the first-made half core the plate must be reversed, this being done after the removal of the first half core upon a supporting sand bed. In both cases central bearing irons are placed in the cores during their formation, to give stability to the core and allow the securing of the halves together. In many instances the irons are allowed to project beyond the print's extremities to serve this latter purpose. Cores of this type require to be securely bound centrally, and for this the core

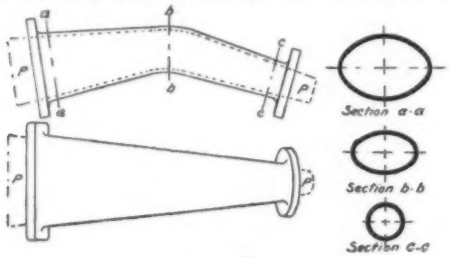


FIG. 89.

is cut away sufficiently at a desired position. In every case the joints are levelled and pasted together either by clay-wash or a binder.

Referring again to the strickles, those portions which are in contact with the guide plate are apt to wear very considerably, and precautionary methods to counteract this are necessary. To this end tin-plate may be attached to the strickle at the parts liable to wear, *A*, *B*, *J*, Fig. 84, or "flush" nails may be used, so that the wear is taken upon their heads. Both methods are suitable, and without some such precaution the strickle will soon require re-cutting or replacing.

Fig. 85 shows the relative positions of plate, strickle and core, the latter being formed by the strickle working along the guide edge of the plate, sweeping the sand to the conformity of its strickling edge. The same methods are employed when a guide bar, Fig. 86, or guide plate, Fig. 87, is adopted. The curvature for the guide bar or guide plate allows for the strickle extension at *E*, Figs. 86 and 88, so that in its strickling action the accurate conformity of the core required is obtained. The "cut-back" of the strickle at *F*, Fig. 88, need not necessarily be the bar plate thickness (*T*, Fig. 86), but the portions of the strickle *F*, *G*, *H*, which are liable to wear should be metalled as for Fig. 84. To obtain stability and rigidity during the core-

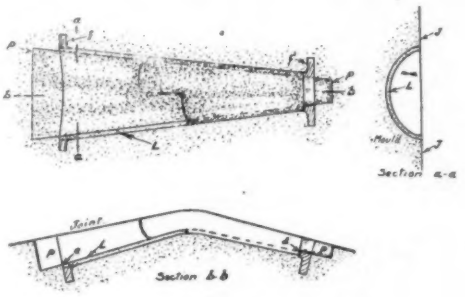


FIG. 90.

strickling process, the bar or plate is usually weighted down upon the core plate, and after being made up this latter with the core is placed into the stove for drying.

The layering of a mould to produce its own core is usually confined to work of an experimental nature, when the expense of a core-box is not warranted or guide-and-strickle methods are prohibitive. The work produced by this method is confined within rather narrow limits, as it entails exceptional care during ramming up so that the mould remains practically undamaged—no easy matter under the conditions imposed. As an example explaining this method may be taken the making of the reduction pipe, Fig. 89, which varies sectionally from the elliptical to the circular and, in the one direction, is bent. Figs. 90 and 91 illustrate the method.

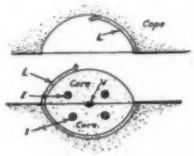


FIG. 91.

The pattern should be moulded in halves and jointed along its shallowest section so that the lift of the core would be the least possible. Within the mould at the flange positions, "dummy" flanges *f*, *f*¹, of wood are placed, these being made to follow out, respectively, the required core section as at *f*¹, or, alternatively, the mould section; the method chosen being that which involves the least amount of expense in pattern-shop labour and time. The mould is skin-dried and black-washed, the blacking acting as a parting medium between the mould and the loam thickness cake which is laid upon its surfaces whilst in a plastic condition. This loam thick-

ness is made heavy with clay and formed within a framed box, the depth of the box being the same as the required metal thickness. No arbitrary size beyond thickness is necessary, as the "cake" is placed upon the mould surface in convenient pieces and made level with the mould joint. When a flange as f^1 is used the loam thickness abuts against the flange and obviously follows out its cut-out core section.

In the case of the flange *f*, however, the thickness is laid within the cut-out portion *e*, Fig. 90, and consequently follows out the contour of the print I^1 where it adjoins the flange. After layering the mould, the thickness *L* is also skin-dried and blackwashed and within it the core is carefully rammed up and sleeked level with the joint. During the make-up of the core the grid or irons, *I—I*, Fig. 91, are placed in position, and, as a rule, project beyond the print extremities for binding and lifting purposes.

The half core made within the cope is anchored through the box to prevent a drop out during the "try over" to examine the joints, and also to ensure its correct relative position with the drag half-core, as the cope is ultimately lifted free, as shown in Fig. 91. The half cores may be parted upon their joints so that the *complete* core may be lifted from the drag, and in these cases a central vent, *V*, would previously be made. Further, the grids or irons in the two half cores would be firmly bound together at the print extremities before being lifted as a completed core. Alternatively, of course, the core may be removed in halves and be jointed after drying; but the method to be adopted would depend upon size and the facilities governing the core's removal.

After the clearance of the core from the mould the loam thickness *L* and the flanges *f* f^1 are removed, the mould being then finished off preparatory for casting.

The Use of Denseners and Heat Treatment of Cast Iron.

At a recent meeting of the Newcastle-upon-Tyne Branch of the British Foundrymen's Association, Mr. J. M. Weir in the chair, a Paper on the above subject was delivered by Mr. R. Carrick, of Shipley, Yorks. The Paper was a digest of the Papers previously delivered by Mr. Carrick.*

In the course of the discussion which followed, Mr. Matthews asked whether Mr. Carrick treated the surface of the chills or denseners in any way.

Mr. Carrick stated that in the case of the round denseners he simply applied a coat of clay-wash and after this had dried he coated them with composition blacking. He had had several letters on this question from different parts of the country. One correspondent had stated that he used a covering of shellac and methylated spirits, but after the denseners thus treated had been used about six times the results obtained were unsatisfactory. This correspondent had, however, taken to using fresh chills, with success. Mr. Carrick, continuing, said that after a certain amount of use the denseners became something like the ordinary grate bars; the carbon burnt out and the whole thing ultimately collapsed.

Mr. Paulin said he had noticed that Mr. Carrick had frequently referred to the mixtures used for the castings as containing a large amount of silicon. In his experience these were not the classes of mixtures used in the North of England. He felt that the use of the chills was more or less a smart dodge to get over a difficulty, but he would prefer as a foundryman to use metal more suitable for the particular purpose for which it was intended. In his opinion a proper mixture of metal if treated with denseners had a tendency to become very bad to machine, and such a mixture was perhaps better left to cool in the ordinary way. On the other hand, he agreed with Mr. Carrick that, other conditions being acceptable, in certain castings, the use of chills would have a valuable effect, as for example in counteracting the tendency to porosity produced by the pull of arms on a heavy boss. Nevertheless, he was not at all in favour of the close grain obtained by using denseners, when resistance to wear was wanted, as he thought that metal in which the silicon was high did not lend itself to producing a good wearing surface; and he considered that with a good mixture a greater amount of endurance would be obtained without the use of denseners. However, it was obvious that the change which took place in the condition of the iron was one that was very interesting, and which could be made use of. He asked Mr. Carrick whether the denseners had been used in the case of work for hydraulic purposes, where a very close texture was required in the metal in order to resist the action of the water. He also asked whether the author had attempted to use a mixture which included steel, and whether the use of denseners in such a case had been successful.

In reply, Mr. Carrick said he appreciated Mr. Paulin's remarks, particularly his reference to the tests being in all cases on high-silicon mixtures. He had dealt mainly with this class of iron as the bulk of the metal he was using had to be of a particularly soft nature for castings only ¾ in. thick or less and which had to be machined. The process was applicable to low-silicon iron up to a certain point. No hard-and-fast rule could be drawn. Of course, when using low-silicon iron the application of denseners, after a certain point, produced white iron. In his experience of low-silicon iron, he had never come across a large fly-wheel of absolute solidity throughout, and he took it these were made by foundrymen who had chosen the best quality of iron for the particular purpose. He thought Mr. Paulin should withdraw the term "dodge." He thought the process was a fair and square attempt to deal with a very difficult problem. In reply to Mr. Paulin's further question, the process had been used on hydraulic work at various places and with immense success. In regard to the use of an admixture of steel, he had had experience of a mixture containing 40 per cent. of steel.

Mr. Gallon expressed the opinion that the use of a recessed core was of advantage; when these were used in the case of a fly-wheel, the porosity was overcome. Mr. Carrick, however, replied that some inspectors had an objection to the use of recessed cores. Mr. Gallon, continuing, expressed himself as very much in favour of the use of denseners. He thought they would do a lot of good, especially if the engineers would allow their use at the discretion of the foundrymen.

Mr. Quick asked whether a solid densener and consequently a thicker one could not with advantage be used to bring about quicker solidification.

Replying, Mr. Carrick stated that denseners which were thicker than those he had recommended had the danger that if they were not removed at exactly the proper time, chill would set in. The main object to be kept in view in employing the process was the removal of the denseners before there was any possibility of chill having taken place.

* "The Use of Chills to Overcome Liquid Contraction." (F.T.J. Jan., 1913), and "Some Notes on the Heat Treatment of Cast Iron," F.T.J., May, 1914).

A Journeyman Moulder's Opinion of his Craft.*

By J. McNamee.

There is always an amount of art in design, forethought in creating new ideas, and skill required for the construction of any work connected with our various industries. But with the exception of those engaged in foundry practice, there are rules and principles which can be studied at the outset, and which enable those engaged to obtain positive results. Moulders, however, are without any distinct formulae which may be safely followed to produce absolute satisfaction. There are some fundamental factors which govern our work, but these are limited to the materials we use during the operation; the rest depends on the mental faculty of the man.

It is acknowledged that art is the result of work, and depends upon the skill and mental capacity of man, without the aid of formulæ. Iron-moulding, perhaps, cannot be classed amongst the fine arts, but it certainly is not crude. It is an industrial art. Considering the problems that remain unsolved in the foundry, and the difficulties which are added each day through the rapid advance of the engineering industry, I think there is no exaggeration in saying that the work of the foundryman calls for more self-reliance, keen foresight, skill and concentration of mind, than those industries which are assumed to be of more importance.

The moulder has no definite method of counteracting the erratic behaviour of the metal he deals with: it is only by practical experience and the judicious use of the materials at hand that he obtains the satisfactory results that are witnessed to-day. It would be impossible, at least from a commercial point of view, to make flasks or casings to accommodate the number of patterns which differ in their thickness, size and contour, so that when a moulder has given due regard to the appliances at hand, and finds he is short to deliver a certain job, his mental faculty is called upon to supply some method that will sustain the mould and metal whilst casting.

Doubtless a knowledge of the nature and properties of sand adds to the interest of foundry work. But though various facts have been deduced in the laboratory, the moulder is again without a positive formula to guide him in practical work; he is still left to his resources. He judges the qualities of the sand by his sense of touch, and adds certain materials and energy to get a desired effect. In consolidating the sand around and in a pattern he is called upon to give due regard to its fragility, firmness of the sand to resist heat and liquid pressure, without impairing the porosity that allows the gases to strike back to the vents.

A practical man obtains a good idea of the class of metal he is dealing with by its appearance as it stands in the ladle; but there is no authority as yet to state precisely what action the gases will assume during solidification at the first operation with every mould, under practical working conditions. A moulder knows that a chemical action will take place, and whatever method he may adopt to counteract any irregularity, it cannot be said that he has had the guidance of formulæ. There have been many formulæ given from time to time for the mixing of sands and metals, but they do not give positive satisfaction—they are limited to the circumstances where they originated; for the mixings from different districts vary when dealing with the same class of work. They may be, nevertheless, very useful, when due regard has been given to the altered conditions.

As to the cupola, although it has been the playground for both scientific and empirical methods ever since its institution for practical purposes, it is worked to-day on the same principle as it was half a century ago. Science has certainly made it more productive; yet with all the scientific appliances and under the best regulated conditions the cupola does not at times seem to give the satisfaction desired. There are various theories put forward to explain its uncertainty, and apart from the cupola itself, its conditions, the pig, scrap, coke and flux come in for criticism. I venture to think that under the present conditions good results depends upon the experience and instinct of the foundry foreman.

Foundry employers are often found to advocate a scientific education for their men. If there is a genuine desire to witness enthusiasm for education in the foundry, let an example come from the fountain head by organising to deal with research work so as to make the foundryman's work less precarious. I am quite convinced good results would come of this. There are some moulders who have but one method of working. Their inability to adopt any other may be through lack of foresight, want of proper training in youth, or through specialising in one class of work. There are foremen no doubt similarly placed; perhaps they can only use with confidence one or two brands of iron, with an addition by empirical methods of scrap of various qualities. Then there is the foundry master or engineer who is satisfied with the same old plant and system in the foundry. We cannot, in the light of modern industry, hope to prove successful by impulsive and erratic effort. It behoves us to educate ourselves so as to prepare for emergencies and remove the conditions and circumstances that cause failures; and the only method to effect this purpose is by science, for it is the only means that gives us rules and principles to combat problems or predict what will happen in the future.

With the exception of a few large towns in this country, there are no special arrangements made by educational authorities for the foundry. If an ambitious youth who notices the extensiveness of foundry work comes into the foundry, he will probably be impressed by the sort of chaos that exists. It is quite possible that he might have a desire to add theory to his practice; but if he sees no aid and gets no encouragement, or finds the facilities are not within reasonable distance, he puts the trade down as an uncertainty. Now the smart and ambitious youth bases his career on the classification of facts, and will not tolerate nor launch out on a career of uncertainty.

Theoretical education stimulates our mental faculties and imparts knowledge which is useful in our work. But theory is only successful when added as a supplement to the knowledge of the materials we use, and familiarity with our work, which is only gained by practical experience. Employers want men who are sound both in reason and the economics of industry, to take charge of their foundries. But

* Abstract of Paper read before the Lancashire Branch of the British Foundrymen's Association, April, 1915.

a broad experience cannot be gained down the narrow paths of division and sub-division of labour. The best man to take charge or command is one who has had experience in the different classes and methods of his work during his youth, and has supplemented it with theory.

Further, if the foundry is to be made attractive to the youth, its conditions must be made attractive, and a stimulus given that will act as a spur to the mental faculties. If, in choosing a career, a certain youth shows signs of constructional ability, the foundry affords more scope for its development than many of our sciences. The craft of moulding alone, though it be dirty and perhaps requires some energy, is full of fascination and excitement, tinged with those distressing moments which seem to say, "man know thyself, and take warning by your experience."

If the apprentice is working in a shop that allows him to avail himself of all its resources, he should put his conscience into his work and study the principles that govern his craft. But if he gets into an establishment where his ambitions are obstructed by the human element, or where the immediate interest is to bestow on him only such attention as will make him a productive unit in the shortest possible time, then he should move. For though singleness of purpose is a fine maxim we should all try to follow, singleness of method is hardly conducive to progress in general foundry practice. In any case, a moulder in the early part of his career can with advantage change his situation if he observes the following rules:—(1) Always leave a shop with a good character, for you may find it necessary to return some time; (2) keep within reasonable distance of your educational facilities; (3) never break the home ties for the nursery which fosters those individual and civic virtues, for there are so many cheap attractions to entice the youth who thinks himself a free-lance, and if this freedom is abused, it promotes that insipidity which, when once imbued, prevents the conscience from entering his work, engenders a distrust of fellow-workers, and creates that unsettled spirit which makes a transient worker.

Discussion.

The Chairman (Mr. T. W. Markland) remarked that problems often cropped up in the most unexpected manner, and the only way in which one could prepare to meet them was by continually making experiments. In regard to technical education, he believed they were bringing the employers to see the value and necessity of doing all they could to encourage it, and many of them were actively doing so. At any rate the employers, generally speaking, were looking at the question from a much better and higher standpoint than they did formerly. If they could educate the boys and young men up to a proper standard, foundry work would soon come to be regarded as a science, and attain a greatly improved status.

Mr. Penlington said that in recent years certain formulæ had been discovered or brought forward, which were of great assistance to the foundryman in his work. For instance, a method had been devised by which they could get an amount of pressure to determine the bias and denseness of the sand, so as to enable them to know whether the metal would lie on the form satisfactorily. For the most part those methods applied principally to foundries in which, the work being specialised, there was a continuity of similar jobs. Many of these contrivances, again, had the effect of eliminating to some extent the work of the moulder, the bulk of it being in consequence relegated to the labourer and to the unskilled portion of the workshop. In the jobbing shop those methods did not count for much, but with specialised work they could be used to advantage. Mr. McNamee had referred to science in the workshop. There was a good deal of rule-of-thumb practice; even in foundries which had turned out the best results, the rule-of-thumb prevailed still; but the results were due to the practical knowledge which the foundryman had gained by experience, and which enabled him to tell by look and touch whether matters were going right or not, better than many a man with higher scientific training. He contended that unless founders paid proper attention to the making of the patterns they could not expect to retain their place in the engineering world, or to make much progress in any direction. The apprenticeship question was a burning question now, and would become more and more so as time went on. Firms who had apprentices were finding that the only way to encourage them was by paying big wages. That simply spoiled the boys themselves, and obliged the foreman to keep them on one particular class of work. That in turn rendered the apprentices dissatisfied, because they did not receive the same increases in wages as they did in the earlier stages. Some firms, no doubt, had been encouraging youths to attend technical classes, but the results had not come up to their hopes or anticipations, which might be owing perhaps to the fact that the work in the foundry was laborious and dirty, and boys liked to get into the fresh air. They must endeavour to make the work more attractive and less arduous, and encourage apprentices to study by allowing them time off and not expecting them to do so altogether in their own time.

Mr. Simkiss said that with respect to cupolas, there was one question they might do well to ask themselves, namely, Is it the design of the modern cupola that is at fault? The one he had in use to-day was the best obtainable after many years' experience, but all the same it was not, in his opinion, the right design for melting iron. No two foundrymen would take the same mixture and get the same results. Was it the material they had to use that varied so much? Another matter mentioned was concerning patterns and the design of patterns. The pattern-maker, during his apprenticeship, was brought up amongst a certain class of work, and he became accustomed to the methods of doing things in the adjoining foundry. If he removed to another establishment he naturally carried with him the ideas he had already imbibed. They were aware that, however good a pattern might be, there was always an alternative design on which it could be constructed. The first question they had to ask in regard to a new pattern was—will it fit into our tackle? If it would not, it required making so that it would fit. It therefore followed that foundries that were doing a certain class of work had certain patterns to work with. Something had been said about the foundries being dirty places, but a good deal depended on the managers themselves, and if they would only look after it, they could have the foundry as clean as the machine shop.

Mr. Hogge remarked that at one firm with which he was acquainted, the principals insisted upon the boys attending technical classes, and some of them had to be forced by threats of dismissal; in fact, two were dismissed. That went on for a time, but they could not afford to continue it under present conditions. He did not think that if the hours of labour were reduced to four a day it would make any difference, because the majority of youths now had no interest in anything beyond getting their wages, and getting them in the easiest possible way.

The Edgwick Works, Coventry.

The Birmingham Branch of the British Foundrymen's Association recently paid a visit to the Edgwick Works of Alfred Herbert, Limited, Coventry. The visitors were received at the Works by Mr. E. H. Broughall (works and foundry manager), Mr. J. Ridley (assistant works manager), and the members of the staff.

Since the visit of the Branch to the Edgwick Works about 4½ years ago, considerable extensions have been made. At that time there was on the site only the foundries and a small machine shop. But now a considerable area of land has been added and some large and important buildings have been erected which form an important addition to the Company's manufacturing facilities. The area in the occupation of the Company at Edgwick comprises about 17 acres, of which about seven acres are already covered with buildings, whilst further extensions will shortly be undertaken. As far as possible, the arrangement is on the most modern lines as regards the relative situations of the different departments, and ready communication between them. The transport of material, castings, and products in different stages of manufacture between the various departments of the works is facilitated by a railway track and small locomotive, whilst each shop is well provided with cranes and overhead travellers. At Edgwick there are about 700 workmen, whilst at the head works at the Butts, the older establishment situated near the centre of the town, the number is about 1,300. The foundry department at Edgwick, including the pattern shop and other adjuncts, employs about 300.

The new machine shop is a lofty and well-lighted building and is constructed so as to facilitate extensions by lengthening the bays. The bays have a uniform width of 30 ft. The roofing is of light construction and is covered on the one side with glass and on the other with corrugated iron, lined with Uralite sheets. The shafting and countershafting are carried on girder work supported from the floor. The driving is by electric motors, generally in units of 35 h.p., and the shafting is run at a uniform speed of 200 r.p.m. Machines of similar type are grouped together so as to be under the supervision of gang charge-hands. Jigs and tools are issued from and returned to the tool stores, where they are kept in good condition by a special staff. Exceptionally good provision is made for heating and ventilation, the Sturtevant "Plenum" system having been adopted, of which there are in all five batteries, each consisting of a fan which draws fresh air from above the roof, blows it over a live-steam radiator and then distributes it by means of pipes to the floor of the shop. In summer the heaters are not used, but the fans continually deliver fresh air at atmospheric temperature. All machines are tested before despatch up to a pre-determined output by a representative of the selling department. The motor driving the machines for testing purposes is fitted with meters showing the power absorbed by machines under test.

The small-tool department is used for the production of tools, jigs and fixtures for use in the works. An interesting machine in this department is the jig boring machine, designed and manufactured by the Company, on which extremely accurate setting of the table can be made and checked. By means of the special micrometer, measurements of 0.00025 in. can be easily made.

In the detail inspection department, component parts of machines are checked after each operation and then forwarded to the department in which the next operation is to be carried out. A careful check is kept of the progress of each part. In the stores assembling department the component parts are assembled and issued in complete sets to the fitting department. This department also deals with all finished material ordered out. The warehouse in which finished machines and attachments are stored to await dispatching instructions is another example of orderly and efficient organisation.

In the hardening department for the annealing and heat-treatment of steel, hardening and tempering of steel parts, case-hardening, and annealing of grey-iron castings, there are four ovens of the firm's own design and manufacture, together with gas furnaces for case-hardening, and furnaces for hardening high-speed steel. The temperatures are measured by Féry radiation pyrometers.

The power station is conveniently situated with regard to the other departments, and also has the advantage of being close to the canal, by which the fuel is brought in. In the boiler house are four Babcock & Wilcox water-tube boilers equipped with chain-grate stokers and superheaters. Steam is generated at 160 lbs. per sq. in. pressure with 100 deg. F. of superheat. A Green's economiser of 128 pipes is also employed. In the power house are two 300-i.h.p. combined Robey engines. The generators, by the Lancashire Dynamo Company, Limited, are mounted direct on the crankshaft and generate direct current at 230 volts, 760 amperes. The condensing plant is in the basement. The power installation also comprises one rotary converter taking alternating current from the Corporation supply and converting it to 230 volts direct current, and running in parallel with the other plant. This has a similar output.

The visitors were introduced to the foundry department by way of the sand-preparing shed. Red sand is delivered by canal and stored in the bunker in the floor of the shed. The Company's patent sand-mixing machine for mixing and aerating moulding sands was seen at work. As is well known, this machine has now been placed on the market. The plant in the sand shed also comprises a mechanical riddle for riddling old sand and a coal-dust grinder and riddle. The sand when mixed is stored in bins according to quality.

The larger foundry, known as No. 1, is used for the production of larger castings, and mostly in dry sand. The moulds are dried in stoves or by the "Piftin" portable dryer. In the construction of the moulding boxes some of the points specially noticed were the rounded corners and solid boxes, the planed joints and interchangeable pins fitted in bored holes on all boxes. Boxes up to 24 in. square are jig-drilled and made to interchange. The cupolas comprise two No. 5 Thwaits' with receivers and drop bottoms. Blast is supplied by a belt-driven fan, and the floor is served by two 5-ton electric cranes with supplementary travellers worked by hand.

In the pattern stores there are two distinct departments. The pattern stores "A" serves for the storage on the ground floor of the larger standard patterns and core boxes, and on the upper floor of lighter patterns. The light patterns are stored on numbered shelves easily accessible and well lighted. A record is kept of all patterns by a card-index system. The pattern stores "B" is for the storage of patterns used on moulding machines. Over 2,000 patterns are prepared for moulding-machine purposes.

In the laboratory, in which testing work is done for the Edgwick Works and also for the head works at the Butts, the equipment includes an Avery 20-ton testing machine, a Denison testing machine, a Keep's apparatus for shrinkage tests, a Pratt & Whitney precision measuring machine, a special machine designed and made by the Company for accurately checking the dimensions of screw threads, a Shore scleroscope for hardness testing, a Stead's shop micrometer, and a microscopic measuring apparatus for Brinell tests. The upper floor is devoted to analytical testing of metals and materials and includes in its apparatus a Redwood viscometer for oil testing, and a calorimeter for testing the calorific value of fuel.

In the No. 2 Foundry, which is for the production of lighter castings, mostly machine-moulded, there are seven 14-in. by 16-in. and one 24-in. by 24-in. Tabor moulding machines, worked by compressed air at 80 lbs. pressure. In this foundry a great many of the castings are made in iron moulds. A large proportion of the chilled castings are in the form of chilled bars, of which fairly general use is made in the products of the firm. In the machine shops had been seen some of the chills for this purpose. The chills are made into sections and are planed out accurately to the requisite diameter. The pattern plates for the Tabor moulding machines are also made in the No. 2 foundry. This foundry is served by a Thwaites cupola, No. 4 size, with drop-bottom and receiver, and a 2-ton electric travelling crane. A No. 5 cupola is shortly to be added, with a large charging platform and electric lift. A blower with variable-speed electric motor is also to be installed.

In the bronze foundry are cast bronze, white metal and gunmetal castings, and the melting is done in six Carr's crucible furnaces. A 14-in. by 16-in. Tabor moulding machine is used for the production of repetition work. In this foundry a certain amount of work for other firms is done, though the other foundry departments are fully occupied with the firm's own casting requirements. Gunmetal and bronze turnings from the machine shops are melted down and chemical analyses of each melting are taken and recorded.

The fettling shop contains two rumblers, the larger one being capable of dealing with two or three tons of heavy articles at once. The rumblers have dust-exhausters designed and made by the Company. The dust is exhausted into an underground trench, and delivered by pipes to a dust arrester in the yard, where it is drawn out in the form of mud. The shop also has a sand-blast plant for iron castings. All parts of machines used as oil baths are sand-blasted and then carefully painted. All castings are painted immediately after fettling, with lead paint, and so all rusting is prevented. Near at hand are the casting stores, where all castings for the head works and the Edgwick Works are stored to await delivery.

The cutting-off and steel stores are used for the storage of steel bars and forgings. In this department all steel blanks are cut to the correct length from the right grades of steel to make component parts of the machine and are here stamped indicating the quality, order numbers, and upon which batch of machines they are to be used. Steel bars are reeled after heat treatment, to break up the scale and straighten the bar. There is also in this department an oil-filtering plant which thoroughly filters, cleans and sterilises the oil from the automatic machines in the factory. After this treatment the oil is put back into the factory supply tanks.

The pattern shop is of light construction and is heated and ventilated on the same system as that of the machine shop. The fullest use is made of woodworking machinery, the plant comprising a "Universal" woodworking machine, a planing and thicknessing machine, trimmers, band and circular saws and lathes, a motor-driven swing saw for cutting up timber for packing cases, and automatic machines for sharpening and setting band saws. Adjacent to the pattern shop is a department for the storage of patterns used only occasionally, and patterns of obsolete machines.

Another of the buildings in the manufacturing departments is that known as the factory. This is built in bays of a uniform width of 30 ft., with a roof of the same design and construction as that of the machine shop, and the heating and ventilating on the Sturtevant system are also similar. This shop is not designed to carry cranes, except in the last bay. Consequently, the design of the structure differs in some details. All the line shafting runs on ball bearings at a uniform speed of 200 r.p.m., and is driven by electric motors. This department is specially laid out for the production of Coventry chucks, die-heads, and ball-bearing drills in large quantities. All standard parts for Herbert machines are produced on automatic bar machines in Bay 1. In the adjoining tool-stores department, tools, jigs, fixtures, etc., are stored and kept in good condition and issued to the shop as required, whilst in the detail inspection department component parts are inspected after each machine operation.

At the conclusion of the inspection of the works the visitors were entertained by the firm to tea, and on the proposal of MR. GIMSON (President of the Association), a very hearty vote of thanks to the Company and its staff for their entertainment was carried, MR. BROUGHALL replying on behalf of the firm.

Use of Pulverised Coal.

About 10 years ago the American Iron and Steel Manufacturing Company, of Lebanon, Pennsylvania, commenced the experimental use of pulverised coal in its furnaces. From the first it was apparent that the successful use of this form of fuel depended upon the absolute control of the feed to the burner. After considerable experiments, a suitable feeding device was developed, and at the present time the company is burning pulverised coal in over 100 furnaces of various types. The fuel is pulverised so that over 80 per cent. will pass through a 200-mesh sieve. The burners feed from 40 to 900 pounds of coal per hour, depending upon the amount of heat required. Experiments made last year indicate that from 1,169 to 1,472 lbs. of coal are required to produce one ton of puddle bar from grey forge pig-iron. The coal is conveyed automatically from the wagons to the pile, from which it is taken by screw conveyors to the dryers and pulverisers. As the coal leaves the pulveriser plant it is weighed on a large automatic scale. Screw conveyors are also used for conveying the pulverised fuel to the various points of consumption. A tank or hopper of sufficient size to carry about 15 hours' supply of pulverised coal is attached to each of the furnaces. On several occasions the fuel has ignited in these hoppers, usually on Monday morning, when it has had time to accumulate moisture. In such cases it is only necessary to stop the supply and to feed the burning coal into the furnace until the hopper is empty. There is no danger of explosion under these conditions. The fuel is delivered to the puddling and heating furnaces at a low air pressure, from four to six ounces of blast pressure being used to deliver the coal through a small pipe to the large blast pipe, which in

a heating furnace is from 10 to 14 in. in diameter. In 1907 the average quantity of unpulverised coal required to produce a ton of puddled bar was 2,052 lbs.; in 1908 it was 2,034 lbs. Tests made in 1913 indicated that from 516 to 570 lbs. of pulverised coal are required for heating one ton of iron in the piling furnaces.

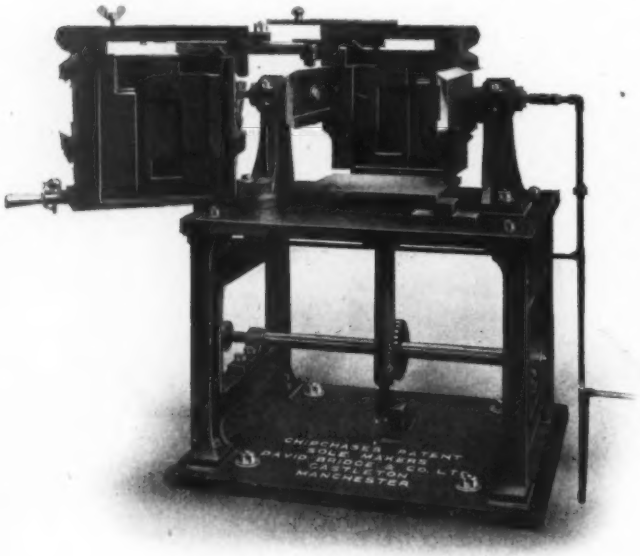


FIG. 1.—CORE-MAKING MACHINE OPEN.

Chipchase's Core-Making Machine.

The accompanying illustrations show Chipchase's core-making machine, which is manufactured by Messrs. David Bridge & Company, Limited, engineers and founders, of Castleton, Manchester. This is a hand-operated machine, but a type of similar design to operate by power on the jar-ramming principle is also manufactured by the firm. The machine now illustrated consists principally of a core-making box which is arranged in halves, each half sliding on parallel vee blocks. These blocks are arranged on trunnions so that the box can be turned in a complete circle for the ramming or withdrawing of special slip prints. At the end of each trunnion is arranged a Bunsen burner which heats cavities in the box, so that the sand will harden and easily leave the iron core box. The mechanism under the machine operates a table which carries the core when the two halves of the core box are being parted, thus dispensing with the handling of the core.

FIG. 2.—MACHINE CLOSED AND CORE BEING RAMMED.

FIG. 3.—BOX RAMMED AND BEING TURNED OVER.

The accompanying views show the operation of the machine producing a core for a railway axle box. In Fig. 1 the apparatus is depicted open, showing the arrangement of the parts. Fig. 2 shows the machine closed and the operator ramming the sand, while in Fig. 3 the box is being turned over after having been rammed. Fig. 4 illustrates the withdrawal of special prints, while in Fig. 5 the box is open and the core ready for removal.

It will be seen that this apparatus is simple in operation, but ensures cores of absolute accuracy, and prevents many of the troubles occasioned by much handling of box and core. The mechanism is not complicated, and involves nothing that can get out of order with ordinary usage.

British Foundrymen's Association.

Lancashire Branch.

The annual meeting of this Branch was held at Manchester on May 1. Mr. J. Simkiss presided, in the unavoidable absence of Mr. T. W. Markland, the President.

Mr. Harrison (Hon. Secretary), in his annual report, stated that the past session had been fairly satisfactory, and on the financial side there was a balance in hand.

On the suggestion of Mr. Sherburn, the Secretary was requested to write to the four members of the Branch who are serving with the colours, assuring them that they were remembered at the annual meeting, and sending them hearty good wishes.

The Chairman said a letter had been received from Mr. T. W. Markland, intimating that in consequence of the state of his health, he must ask to be relieved of the office. The Council felt bound, though with regret, to accede to Mr. Markland's wishes, and he had much pleasure in moving that Mr. H. Sherburn be elected President for the coming year. He did not know anyone who could take up the office with greater prospects of success, and he was sure he would endeavour in every way to further the interests of the Branch.

Mr. Sutcliffe seconded, and the resolution was carried unanimously, amid applause.

Mr. Sherburn thanked the Branch for the honour they had done him, and added that he was proud to undertake the responsibility since it was their wish that he should do so.

Mr. Harrison was re-appointed Secretary by acclamation, and Mr. Key, Junior Vice-President; Messrs. T. Craig, Pemberton and McNamee were elected on the Council in place of Messrs. Key, Hargreave and Sanderson, the other members being re-elected. Messrs. H. Grandidge and Nicholls were appointed auditors.

On the proposition of the Chairman, seconded by Mr. W. H. Sherburn, a hearty vote of thanks was accorded to Mr. Markland, the retiring President, for his valuable services on behalf of the Branch.

Fig. 4.—Withdrawal of Special Prints.

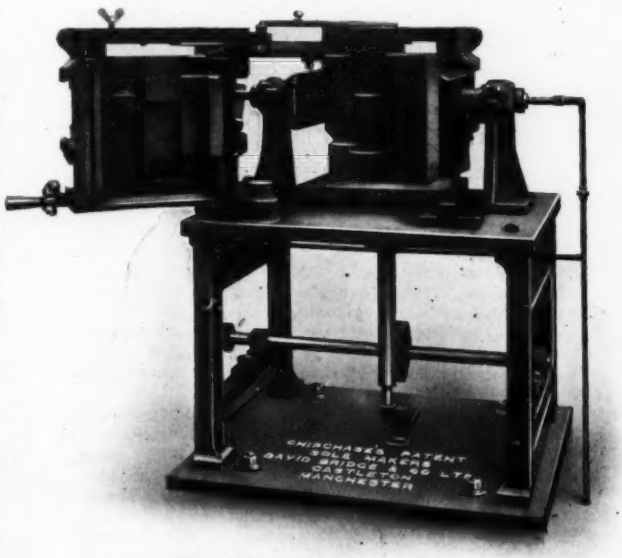


Fig. 5.—Box Open, Showing Core Ready for Removal.

CEYLON PLUMBAGO FOR BRITISH FOUNDRIES.—The Technical Information Bureau of the Imperial Institute has issued a circular dealing with plumbago, its uses and sources of supply, having special reference to the Ceylon product. Samples of the Ceylon graphite may be seen, and other particulars obtained at the Institute, South Kensington.

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The Iron and Steel Institute.

Annual Meeting in London.

The forty-sixth annual general meeting of the Iron and Steel Institute was opened at the Institution of Civil Engineers, Great George Street, Westminster, on May 13, under the chairmanship of Mr. Arthur Cooper.

The CHAIRMAN, in opening the meeting, announced that the Council very much regretted that the President was not able to attend the meetings for reasons which would be understood on referring to the Report of the Council, and they had asked him (Mr. Cooper) to preside in the President's absence.

The Report of the Council stated:—Since the beginning of the war in August, direct communication with Dr. Adolphe Greiner, the President, has unfortunately been impossible; but from time to time news concerning him and his family have been received through various channels. During the siege of Liége, and from that time onwards, Dr. Greiner has remained at his post, continually encouraging with his unfailing spirit the members of the staff of the Cockerill Company, and his workmen, and organising means for the alleviation of the distress of the large industrial population dependent on the Company for employment. Notwithstanding the many anxieties through which he has passed, the latest news indicates that his activities are undiminished, and that he and his family are in good health. In the enforced absence of Dr. Greiner, Mr. Arthur Cooper, the immediate Past-President, has added to his many services to the Institute by kindly performing the duties of the presidency.

The number of new members who were elected during the year is 116. The total membership of the Institute on December 31, 1914, was 2,086. Among these there are no fewer than 632 foreign members, of whom, at the outbreak of the war in August, 101 were of German, Austrian, or Hungarian nationality. Since August there have been two deaths and nineteen resignations of German members, leaving eighty names still on the register.

It was decided that the names of members of the Institute on active service in the armies of the Allied nations should be enrolled in a special list for preservation in the records of the Institute.

The Council offer their congratulations to several Members of the Institute who have had distinctions conferred upon them:—Dr. Thomas Kirk Rose, Chemist and Assayer at the Royal Mint, and Mr. John Cowan of Edinburgh, have each had the honour of knighthood conferred upon them; Colonel S. M. Renny has been created Companion of the Order of the Indian Empire; Mr. Charles F. Rand has received the Order of Isabela la Católica and the Grand Cross of a Knight Commander of Spain; Dr. J. E. Stead (Vice-President) has had conferred upon him the honorary degree of Doctor of Science of the University of Manchester; Mr. W. R. Lysaght has been appointed High Sheriff of Monmouthshire; Mr. W. H. Ellis has been elected Master Cutler of Sheffield; and Mr. C. A. Edwards has been appointed to the Chair of Metallurgy and Metallography at the Manchester University.

The total receipts for the year amount to £6,310 8s. and the expenditure to £5,805 16s. 1d. There is thus an excess of income over expenditure amounting to £504 11s. 11d.

The Vice-Presidents and Members of Council due to retire at the Annual Meeting are:—*Vice-Presidents*, Dr. J. E. Stead, Mr. G. Ainsworth, and Mr. J. M. Gledhill. *Members of Council*, Mr. A. Lamberton, Mr. W. H. Hewlett, Mr. C. P. E. Schneider, Mr. W. H. Ellis, and Mr. C. J. Bagley. Mr. Lamberton, Mr. Hewlett, Mr. Schneider, and Mr. Ellis having in the meantime been elected Vice-Presidents, the list of those members due to retire now consists of Professor Henry Le Chatelier, Sir John S. Randles, Mr. W. R. Lysaght, Mr. C. J. Bagley, and Mr. J. H. Darby. No other Members having been nominated up to one month previous to this meeting, in response to the announcement made at the last meeting, the retiring members, subject to the changes specified, are presented for re-election.

Bessemer Gold Medal.

The CHAIRMAN said the Bessemer Gold Medal for 1915 had been awarded by the Council to M. Pierre Martin, the inventor of the open-hearth process for the manufacture of steel. Mr. Martin's health unfortunately prevented his being present at the meeting on the present occasion, and His Excellency the French Ambassador had graciously consented to receive the medal on behalf of his compatriot. Unfortunately, however, urgent duties had required the Ambassador's presence elsewhere, and at his request M. de Fleuriau, Counsellor of the French Embassy, had been kind enough to attend as his representative. M. de Fleuriau was accompanied by Captain Paul Zédé, one of the officers attached to the Embassy, to whom the Institute also extended a cordial welcome as the nephew of M. Pierre Martin.

M. DE FLEURIAU, in accepting the medal, thanked the Institute very much for their kindness in presenting it, and said he would convey it to M. Martin. All he could say was that he happened to know, in his official capacity, that most of the shot fired now by the French against the enemy was made of steel which was manufactured in Great Britain.

CAPTAIN PAUL ZEDE, in returning thanks for the honour done to his family, said his uncle, Pierre Martin, would have had great pleasure if he had been able to come himself on the present occasion.

The following telegram was read from M. Pinot:—"The Comité des Forges de France desire to unite and express their sincere good wishes to President Greiner, and also their cordial thanks at the honour done to M. Pierre Martin, and they hereby transmit to their allies, the British ironmasters, their expression of their greatest confidence in victory."

Discussion ensued on the various Papers presented to the meeting, abstracts of which will be given in later issues.

The following is the list of Papers submitted:—

(1) "Diffusion of Carbon in Iron," by F. W. Adams, B.Sc.

(2) "Supplementary Notes on the Forms in which Sulphides may exist in Steel Ingots," Part II., by J. O. Arnold, D.Met., F.R.S., and G. R. Bolsover.

(3) "Researches on Iron, Silicon and Carbon Alloys," by G. Charpy and A. Cornu.

(4) "Corrosion of Iron in Aqueous Solutions of Inorganic Salts," by J. A. Newton Friend, D.Sc., Ph.D., and P. C. Barnet, B.Sc.

(5) (*a*) "Relative Corrodibilities of Grey Cast Iron and Steel"; (*b*) "Note on the Removal of Rust by Means of Chemical Reagents": by J. A. Newton Friend, D.Sc., Ph.D., and C. W. Marshall.

(6) "Communication on the Heating of an Open-hearth Furnace by Means of Tar," by A. Greiner, D.Sc.

(7) "Sound Steel Ingots and Rails," by Sir R. A. Hadfield, D.Sc., D.Met., F.R.S., and G. K. Burgess, D.Sc.

(8) "The Nature of the A$_3$ Transformation in Iron," by K. Honda.

(9) "Brinell Hardness and Tenacity Factors of a Series of Heat-treated Special Steels," by A. McWilliam, D.Met., and E. J. Barnes.

(10) "Thermo-electric Properties of Special Steels," by A. M. Portevin and E. L. Dupuy.

(11) "Stress-strain Loops for Steel in the Cyclic State," by J. H. Smith, D.Sc., Wh.Sc., and G. A. Wedgwood, B.Sc., Wh.Sc.

(12) "Detection of Burning in Steel," by J. E. Stead, D.Sc., D.Met., F.R.S.

(13) "Iron, Carbon, and Phosphorus," by J. E. Stead, D.Sc., D.Met., F.R.S.

At the Second Day's proceedings on Friday, May 14, the chair was again taken by Mr. Arthur Cooper.

The Enemy Members Question.

The CHAIRMAN, in opening the meeting, said that attention was called at the meeting held on the previous morning to a paragraph in the Report of the Council having reference to alien enemy members. Having regard to the strong expression of opinion of the members present at the previous morning's meeting, a Council meeting had been held on the previous day, and the Council then decided to amend the Report. In addition, the Council adopted the following resolution:—"That the names of all alien enemies be struck off the list of members of the Institute, and that steps be taken to amend the by-laws so that they provide for the future that, in the event of war existing between this and other countries citizens or subjects of which are Honorary Members or Members of this Institute, such Honorary Members or Members shall *ipso facto* cease their membership." He presumed the resolution the Council had adopted in reference to the striking off of the names of all alien enemies was accepted by the members.

Assent was signified unanimously.

Carnegie Gold Medal.

The CHAIRMAN said it was his pleasing duty to announce that, by the unanimous vote of the Council, the Carnegie Gold Medal for the year 1914 had been awarded to Mr. Eugene Nusbaumer, of Paris. Mr. Nusbaumer was educated at the University of Paris and afterwards was appointed chief chemist at the works of Messrs. G. Derihon, at Loncin-lez-Liége, Belgium. During the time that he held that position he carried out an important series of investigations on the wear of metals, and on alternating stresses, the results of which were contributed, in 1909, to the Copenhagen Congress of the International Testing Association. In 1912 the Council of the Iron and Steel Institute awarded him a Carnegie Research Scholarship to enable him to carry out experiments in connection with the testing of materials, the results of which he presented to the Institute last year in the form of a report entitled "Rotary Bend Tests, Alternating Bend Tests, and Repeated Shock Tests." After spending several months in the United States, Mr. Nusbaumer returned to France, in August of last year, where he now held a position as departmental manager of the Puteaux Arsenal, near Paris. It afforded him, on behalf of the Council, very great pleasure to hand the Medal to Prof. le Chatelier for presentation to Mr. Nusbaumer.

The CHAIRMAN then presented the Medal to PROF. LE CHATELIER, who, speaking in French, thanked the Institute, on behalf of Mr. Nusbaumer, for the honour conferred upon him.

Carnegie Scholarships.

The SECRETARY (Mr. G. C. Lloyd) announced that awards of Carnegie Scholarships of the value of £100 each had been made by the Council to the following:—Messrs. E. L. Dupuy, Paris; J. A. N. Friend (second award), Worcester; T. G. Thompson, Washington, U.S.A.; W. D. Helderman, Utrecht. Further grants of the value of £50 each had been made to:—Messrs. H. B. Cronshaw, Cambridge, and H. M. Boytston, Cambridge, U.S.A.

Discussion of Papers was then resumed.

British Foundrymen's Association.

Birmingham Branch.

The annual meeting of the Birmingham Branch of the British Foundrymen's Association was held on April 24, Mr. C. Heggie in the chair. The Secretary's report for 1914 showed that six meetings had been held, including a joint meeting with the Birmingham Metallurgical Society. There had been five well-attended Council meetings and eight visits.

Officers for the forthcoming session were elected as follows:—Mr. D. Dalrymple, President; Mr. John Shaw, Senior Vice-President; Mr. I. I. Howell, Junior Vice-President. Mr. C. Grindlay was re-elected Hon. Secretary and Mr. C. Mace was re-elected auditor. The Council were chosen as follows:—Messrs. R. Buchanan, P. G. Bayliss, J. Bullock, F. E. Robinson, J. H. Toy, H. Winterton, A. Harley, C. B. Roe, C. B. Pugh, H. Mather, F. Holberry, H. L. Reason, C. Heggie, and H. Pemberton. It was further decided that the two Vice-Presidents as usual become the Branch Representatives on the General Council.

"F.T.J." Bookshelf.

Apprenticeship in Ironmoulding. By Fred. Longden. (London: Hodgson Pratt Memorial, Limited, 60, Knatchbull Road, S.E.—6d.)

This booklet of about 60 pages gives a comparison of apprenticeship conditions in English and Belgian foundries (of course, prior to the war). The author is a "Hodgson Pratt" student at Ruskin College, Oxford, and the report, which is the outcome of a travelling scholarship awarded by the Committee of the Hodgson Pratt Memorial, is characterised by thorough knowledge of the trade, and a careful insight into the conditions affecting its well-being. Without wasting words, the author goes straight to the heart of each subject he discusses, and draws a picture which demands the careful consideration of everyone who is interested in the question of foundry apprenticeship. The bias, if there is any, in the statements made is rather in favour of the workman, but this is desirable inasmuch as the rank and file of a trade have a difficulty in becoming articulate in any controversy. There are statements made galore by employers as to the poor class of boys obtained in the foundry and the difficulty of dealing with them; but the review now before us takes a more impartial view, and exposes some of the inequities of existing systems of boy employment. We commend the booklet to all who are concerned with the progress of the trade.

Trade Talk.

THE works of the Barrow Hematite Steel Company, Limited, came under Government control on Monday, May 17.

THE works of Messrs. Drummond Brothers, at Ryde's Hill, near Guildford, have been very badly damaged by fire.

MESSRS. EDWARD PRYOR & SON, manufacturers and merchants, have removed to the West End Works, 112-116, Rockingham Street, Sheffield.

THE shareholders of Poulson's Foundry Specialities, Limited, will meet at Leeds on June 21 for the purpose of considering the liquidator's report.

THE offices and headquarters of the Institute of Marine Engineers have now been removed from Romford Road to the Minories, Tower Hill, London, E.

MR. J. WISHART, 138, Bath Street, Glasgow, has been elected trustee of the sequestrated estates of John Daniel Macdonald, ironfounders' agent, Glasgow.

AN explosion has occurred at the South Wales Works, Llanelly, of Richard Thomas & Company, Limited, as a result of which seven men sustained more or less serious injuries.

A FIRE occurred at the works of William Heaton & Company, Limited, brass and ironfounders, Mill moor, Rotherham, on May 1, considerable damage being done to a storage building.

DUNLOP, BREMNER & COMPANY, LIMITED, engineers and shipbuilders, Port Glasgow, are carrying out considerable improvements at their establishment, including an extension to the engine shops.

A MEETING of the shareholders of the Airdrie Iron Company, Limited (in liquidation), will be held at 34, West George Street, Glasgow, on June 23, to receive the account of the winding-up.

THE shareholders of the Albert Dock Engine Works Company, Limited, will meet at 138, Leadenhall Street, London, E.C., on Monday, June 14, for the purpose of considering the liquidator's report.

THE THERMO ELECTRIC ORE REDUCTION CORPORATION, Limited, of Luton, have delivered to Sheffield users, through their agents, Messrs. T. H. Watson & Company, their first consignment of tungsten powder.

MESSRS. FERGUSON BROTHERS, engineers and shipbuilders, of the Newark Works, Port Glasgow, are engaged on the erection of a new building to replace the workshops and offices destroyed by fire some time ago.

THE extensions to the engine works at Greenock of John G. Kincaid & Company, Limited, Clyde Foundry, Greenock, have been completed, and the installation of the various new machine tools is now proceeding.

ELDER'S COLLIERIES, LIMITED, announce that the Board of Trade have now sanctioned a change in the name to Celtic Collieries, Limited, and in future these collieries will be known by the title of Celtic Collieries, Limited.

AN office has been opened at Queen Anne's Chambers, Westminster, S.W., by Messrs. Parmiter, Hope, and Sugden, of the Hulme Electrical Works, Manchester. This branch will be under the charge of Messrs. Nathan and Allen.

THE partnership heretofore subsisting between Messrs. T. B. Percy, W. Odam, R. W. C. Barber and A. Yeo, carrying on business as engineers, at 8, Martin Street, Plymouth, under the style of Stark & Company, has been dissolved.

THE SHROPSHIRE IRON COMPANY, LIMITED, of Hadley, near Wellington, Salop, inform us that Mr. Joseph Gittings, 43, Woodland Road, Northfield, Birmingham, has ceased to represent them. In future the firm will conduct all business matters direct.

MESSRS. A. D. MATHEWS and C. E. TIMINGS, carrying on business as fender manufacturers, brassfounders, etc., at Cambridge Street Works, Cambridge Street, Birmingham, under the style of Mathews & Timings, have dissolved partnership.

A PETITION has been granted by the Sheriff of Lanarkshire at Glasgow at the instance of J. Wright, engineers' agent, 147, Bath Street, Glasgow, for sequestration of the estates of J. D. Mackenzie, engineer and agent, 199, St. Vincent Street, Glasgow.

THE PEARSON & KNOWLES COAL AND IRON COMPANY, LIMITED, have been granted licences under the following German patents:—27,290, 1904, furnace hoists, J. Pohlig, Akt.-Ges.; 20,598, 1907, charging mechanism for blast furnaces, Aumund; 19,294, 1909, furnaces, J. Pohlig, Akt.-Ges.

THE average price of Scotch pig-iron warrants during April was 72s. 8¾d., compared with 67s. 0¾d. in March, 62s. 6d. in February, 62s. in January, 58s. 10½d. in December, 55s. 11½d. in November, 55s. 7½d. in October, 57s. 1¾d. in September, 58s. 3¾d. in August, 57s. 3½d. in July, and 57s. 0½d. in April, 1914.

A FIRE broke out recently in the engineering works of David Auld & Sons, Limited, Rochester Street, Glasgow. By the time the brigade arrived the fire had a firm hold of the fitting and machine shop, a one storey building about 70 feet by 50 feet, and the roof was destroyed, while considerable damage was caused by water.

THE business of iron and steel manufacturers, which was carried on by the late Mr. D. Sturrock under the style of the Carntyne Iron Company, at the Carntyne Rolling Mills, Parkhead, Glasgow, has been acquired from the late Mr. Sturrock's trustees, by the Carntyne Iron and Steel Company, Limited, 187, West George Street, Glasgow.

"NEPTUNE" is the title of an Anglo-Belgian commercial paper, with an old Belgian reputation. It is now being published at Bank Chambers, 329, High Holborn, London, W.C. The publishers will be glad to send "Neptune" for one month free of charge to any of our readers if they mention the FOUNDRY TRADE JOURNAL in their application.

THE plant of the Cumberland Waste Heat Owners Company, Limited, in which the Whitehaven Hematite Iron and Steel Company, Limited, are largely interested, for the conversion of the waste gases from the furnaces at Cleator Moor into electrical power for the ore mines in the north-west district is expected to be in operation by the end of this month.

THE partnership heretofore subsisting between Messrs. F. C. Grund, W. H. A. Butterfield, A. E. Frost and T. B. Batchelor, carrying on business as electrical engineers and manufacturers, at 63, Turnpike Lane, Hornsey, under the style of the Coleraine Manufacturing Company, has been dissolved so far as concerns Mr. T. B. Batchelor

THE Iron, Steel, and Ironmongery Trades of Scotland Motor Ambulance Committee has presented to the Scottish Branch of the Red Cross Society a fourth ambulance, "Scotia's Iron Queen No. 4." The money received amounts to almost £2,000, and the Committee, of which Mr. Herbert Beard, Gartcosh, is the chairman, has not yet concluded its labours.

THE BROKEN HILL PROPRIETARY COMPANY, Melbourne, announce that the final agreements in connection with the Port Pirie Smelting Works have been signed, and the new company has been registered under the title of the Broken Hill Associated Smelters Proprietary, Limited. The official opening of the iron and steel works at Newcastle (N.S.W.) took place on the 2nd inst.

ACCORDING to Messrs. W. Jacks & Company, the average price of Cleveland warrants during April was 66s. 7d., which compares with 61s. 8¾d. in March, 56s. 5¼d. in February, and 56s. 2d. in January. The average price for each month last year was as follows:—January, 50s. 6¼d.; February, 51s. 1d.; March, 50s. 7d.; April, 51s. 0¼d.; May, 51s. 4d.; June, 51s. 2¾d.; July, 51s. 3¼d.; August, 52s. 4¾d.;

September, 51s. 1½d.; October, 49s. 6½d.; November, 50s. 4½d.; December, 52s. 6½d.

THE proposal of the directors of Baldwins Limited, for the absorption of the Port Talbot Steel Company, Limited, was approved last month by the shareholders of the former company, at an extraordinary general meeting of Baldwins, Limited, held at Birmingham, to consider various resolutions increasing the capital of the company and acquiring by exchange for fully-paid shares of the company outstanding shares not held by the company in the Port Talbot Company.

ON April 30 the leasehold engineering works at Dunston, known as the Dunston Engine Works, were offered for sale by auction. The sale was held in compliance with an order of the Chancery Division of the High Court, and together with the buildings, were offered the machinery, plant, railway siding, tools, and good-will of the business. The premises comprises about seven and a half acres of land, including four acres of foreshore, have a river frontage opposite the Elswick works of 985 feet. No offer was made, and the property was withdrawn.

A PETITION has been presented to the Lord Ordinary at Edinburgh at the instance of Thomas Scott & Company, Limited, iron merchants, 51, Grassmarket, Edinburgh, for sequestration of the estates of Thomas Brown & Sons, engineers, ironfounders, etc., Cammo Foundry, Duns, and his Lordship has granted warrant for citing the debtors to appear to show cause why sequestration should not be awarded. A petition for sequestration of the same firm has been presented in the Sheriff Court at Duns at the instance of P. D. Rasspe Sons, Limited, engineers, Windmill Lane, Stratford, London.

THE governing body of the Manchester Municipal School of Technology (University of Manchester), offer research scholarships in technology tenable during the session 1915-16 at the Manchester School of Technology, one being of the value of £80, three of £75, and six of £50, all with fees remitted. Research may be undertaken in mechanical or electrical engineering, and various branches of applied chemistry, including metallurgy and assaying. The scholarships are open to graduates of any University in the British Empire and to other persons possessing special qualifications for research.

JOHN ROBINSON (ROYDS FOUNDRY), LIMITED, will shortly transfer their business from Royds Mill Street, Sheffield, to Ecclesfield. For some time the present works have not been equal to the demand, but in view of the early expiry of the lease and the fact that the works were an old property, the management decided to lay down an entirely new works where there were facilities for future extensions. The site chosen for the new works, Ecclesfield, is only some 4½ miles from the centre of Sheffield, and is in close proximity to Ecclesfield Stations of the Midland and Great Central Railways. The works comprise a substantial block of offices, pattern shop, pattern stores, foundry and machine shops.

WE learn with interest that a movement was a short time ago started by the engineering and other office staff of the British Westinghouse Electric & Manufacturing Company, Limited, to express in a practical form their patriotic feelings, and it was suggested by them to the management of the company that they should undertake in their spare time some manual work on munitions of war. This offer was accepted by the management, and operations were commenced almost immediately. For the present, each man will work a 5½-hours' shift one night per week, commencing at either 6.30 in the evening or 12 o'clock at night. We understand that approximately 300 staff men have already volunteered for work on this basis.

THE annual meeting of the South Staffordshire Iron and Steel Institute was held at the Institute, Dudley, on April 30, Mr. James Rayhould presiding. The secretary (Mr. W. H. Carder) read the annual report, which stated that the number of members was 286, being a decrease of eight compared with the previous year. The amount standing to the credit of the Institute on December 31 last, after providing for all liabilities, was £122, £4 odd less than the previous year. Mr. Joseph E. Fletcher (Dudley) was elected president. Supporting his appointment, Mr. Macfarlane mentioned that the ensuing year would be the jubilee of the existence of the Institute. Replying, the newly-elected president alluded to the growth of technical education in the Black Country, and its valuable bearing on the work of the Institute. Mr. James Procter (Shropshire Iron Company, Limited) was elected vice-president, and Mr. James Piper was re-elected treasurer, and Mr. W. H. Carder secretary.

WITH the object of assisting British industry through the co-operation of the manufacturer, the designer and improver, the Design and Industries Association has been formed in London. At the inaugural proceedings on May 19, Lord Aberconway presided over a large attendance which included: Mr. John Marshall, Professor W. R. Lothaby, Mr. Chas. F. Sixsmith (Manchester), Mr. H. L. Symonds (London Chamber of Commerce), Mr. H. H. Peach (Leicester), Mr. C. C. Brewer, Mr. A. Heal, Mr. H. T. Smith, Mr. F. Pick (Traffic Manager, Underground Railway), Mr. F. E. Jackson, and Sir Robert Lorimer. After some discussion, Mr. J. Marshall moved the following resolution:—"That it is desirable to establish an association of manufacturers, designers, distributors, and others interested in stimulating that national spirit of co-operation which is becoming more and more a vital necessity to our industrial life, and that it be called 'The Design and Industries Association.'" The resolution was carried, and a committee was appointed.

MESSRS. JOHN GILLOTT & SON, of Barnsley, have now closed down their foundry at Saxilby, Lincs., and transferred this portion of the business to the Dominion Works, Barnsley. For some few years the whole of the steel castings have been produced at Saxilby, not only for consumption in their own works but also to meet the demand for the collieries. When, therefore, owing to the congested condition of the machine shops, it became necessary to extend the Lancaster works, it was decided to embody steel and iron foundries in the extensions and thus place the works in a better position to meet the local demand for castings. The present extensions take, therefore, the form of an entirely self-contained works, comprising pattern shop, steel foundry and iron foundry, together with a machine shop. These will, in addition to serving the requirements at the new works, afford some relief to the shops at the Lancaster works, to which they are in close proximity and connected by private road, whilst the site is bounded on one side by the Midland Railway.

THE Council of the University of Sheffield has received a communication from the solicitor of Sir Joseph Jonas, stating that on July 17, 1912, Sir Joseph bequeathed to the Council and Senate of the Sheffield University the sum of £5,000 free from duty upon trust to be applied (1) To found, endow, and equip a testing laboratory in connection with the Applied Science Department of the said University, his intention being that in such a laboratory should always be found the most modern and complete mechanical and other appliances for the purpose of testing metals, minerals, and similar substances, especially those involved in the production and manufacture of steel, and (2) to call the said laboratory by the name of "The Jonas Testing Laboratory." It was provided that the sum of £5,000 should not be payable to the Council and Senate until such Council and Senate should have set apart and provided a suitable building for such laboratory to the satisfaction of his trustees. In view of the importance of such a laboratory to the University, Sir Joseph has now decided to pay over to the University the sum of £5,000 in satisfaction of the bequest which he made in 1912, in order that a commencement may be made without further delay in the preparation and fitting out of the laboratory, the possession of which he feels is of pressing importance at the present time. The Council has agreed to accept the generous offer.

Mr. F. L. Macleod and Mr. Pate (representing Scottish interests) and Mr. Burton and Mr. Atkinson, of the Cleveland Committee, have had an interview at the Admiralty with Admiral Slade (who was accompanied by Mr. F. Gauntlett and Captain Warden) with reference to the export of pig-iron to neutral countries. In reporting on the results of the meeting to Mr. James C. Bishop, secretary of the Scottish Ironmasters' Association, Mr. Macleod says:—"The restriction as to export applies to pig-iron which contains (1) less phosphorus than 0.01 per cent., and (2) less silicon than 1.5 per cent., together with less sulphur than 0.09 per cent., or a total of 1.59 per cent. for both elements. In view of the possibility of a misunderstanding I brought this matter up, and found that the view entertained by the Scottish exporters was clearly accepted. I left Captain Warden an analyses of Scotch pig-iron which you kindly furnished me. We were supplied with draft copies of documents intended to be used, and I enclose same showing the alterations as adjusted in ink. Objection to two members of the Cleveland Committee had been received on the ground that they were ironmasters and also conducted an export business. It was decided that no information was required from applicants for certificates that would in any way prejudice their business through being known by members of committee. You will observe that it is the intention of the Admiralty to permit shipment, without a licence, of foundry pig-iron certificated by the committees, so no application to London will be necessary. Hematite pig-iron and any iron without the restriction applicable to foundry pig-iron will require a licence, and such licence will be obtained direct from London. In a few days the necessary documents for certificates will be prepared and sent to you by the Admiralty."

Personal.

The late Mr. W. W. Horsfield, engineer and boilermaker, Vulcan Road, Dewsbury, left estate valued at £30,960.

The gross value of the estate of the late Mr. D. Sagar, of Messrs. J. Sagar & Company, mill engineers, is £93,632.

The late Mr. F. Thornton, late engineer to the Staveley Coal and Iron Company, Limited, left estate valued at £20,979.

The late Mr. T. S. Clapham, a director of Clapham Bros., Limited, ironfounders, Keighley, left estate of the gross value of £7,193.

Colonel T. E. Vickers, who was taken ill while in France, has, since his return to London, made very satisfactory progress towards recovery.

The late Mr. R. Hall, of Kates Grove Lane, Reading, Berks., brass and iron founder, left estate valued at £6,157 gross, with net personalty £2,362.

Mr. M. B. Snell has been elected Master of the Armourers' and Brasiers' Company. The new Wardens are Mr. D. R. Pontifex and Mr. D. E. Knight.

The late Mr. J. J. Keswick, a director of the Bengal Iron and Steel Company, Limited, left, in addition to real estate, estate of the value of £46,132.

The late Mr. P. Wood M'Onie, partner in the firm of Messrs. A. & P. W. M'Onie, engineers, of Cessnock Engine Works, Copland Road, Govan, Glasgow, left, in addition to real estate, personal estate in the United Kingdom valued at £30,967.

Captain Paul Delalande, late of the Universal Moulding Machine Company, and now of the 10th Regiment of Engineers (French), has been made a Chevalier of the Legion of Honour for bravery on the battlefield. He is at present in the Hospital St. Charles, Toul, France.

Mr. A. E. Hurst, chairman of the Walsall Malleable Ironfounders' Association, has been the recipient of a presentation from the members in recognition of the valuable work done in connection with the negotiations with the men's union and the recent arbitration proceedings before Sir Geo. Askwith.

Mr. Andrew Smith has left his position as mill manager to the Lanarkshire Steel Company, Limited, to take up a similar position with Palmers' Shipbuilding and Iron Company, Limited, at Jarrow. He previously held the position of assistant mill manager to the Frodingham Iron and Steel Company, Limited.

Mr. Ambrose Firth was the recipient of a presentation on May 1, when the staff of the Brightside Foundry and Engineering Company, Limited, gave a dinner at Sheffield to their chairman, Mr. Ambrose Firth, on the occasion of the fiftieth anniversary of his foundation of the company. Mr. T. H. Firth presided over a representative gathering of the staff and commercial friends.

Mr. David Gordon, A.M.I.Mar.E., of the School of Engineering and Navigation, Poplar, E., and assistant secretary of the London Branch of the British Foundrymen's Association, has been given a commission as first lieutenant in the Royal Naval Air Service. His work will for the present lie in the inspection of aeroplanes, propellers and parts.

Mr. A. Henderson, M.P.
(*Minister for Education.*)

Mr. Arthur Henderson, M.P., the Labour representative of Barnard Castle Division, Durham, since 1913, and leader of the Labour Party in Parliament, has accepted a position in the new Government as Minister for Education. Mr. Henderson, who was born in 1863, was a native of Glasgow, and is the first direct representative of the foundry trade to enter a British Ministry. He served apprenticeship as a moulder at Messrs. Robert Stevenson & Company's works at Newcastle, and has long been associated with the Trade Union movement of the foundry trade, having occupied a number of official positions in connection therewith. For some time he was a member of the Newcastle Town Council, and of the Darlington Borough Council, of which he was Mayor in 1913. He is also a Magistrate of the County of Durham.

Deaths.

THE death has occurred of Mr. J. Bailey, proprietor of the Abercarn Engineering Works and foundry, while on a visit to Porthcawl.

MAJOR LUTHER BENT, formerly president and chairman of the Pennsylvania Steel Company, died recently at his home near Philadelphia, U.S.A. He was 86 years of age.

MR. J. S. WHITE died on May 14 at Fishbourne House, Isle of Wight. He was chairman of John Samuel White & Company, Limited, shipbuilders and marine engineers, of Cowes. Deceased was 77 years of age.

MR. A. B. JOHNSON, consulting engineer, died recently at his residence at Berkhampstead, at the age of 68 years. The deceased gentleman was a director of the firm of Flannery, Baggallay & Johnson, Limited, consulting engineers.

MR. DAVID WILKINSON, of Dinas Powis, died at Cardiff on May 5. Mr. Wilkinson, who was 48 years of age, carried on business as a manufacturers' agent at the Western Mail Chambers, Cardiff. For many years he carried on the John Street Iron Foundry at Cardiff, and was the patentee of a furnace of special design.

ONE of the victims of the "Lusitania" crime is Mr. J. R. Kelly, of 172, Beeston Road, Leeds, head of the firm of J. R. Kelly & Company, Limited, engineers and tool makers, Lower Briggate. Messrs. Kelly act as agents for a number of American engineering firms, and Mr. Kelly had been touring the United States for the past four months.

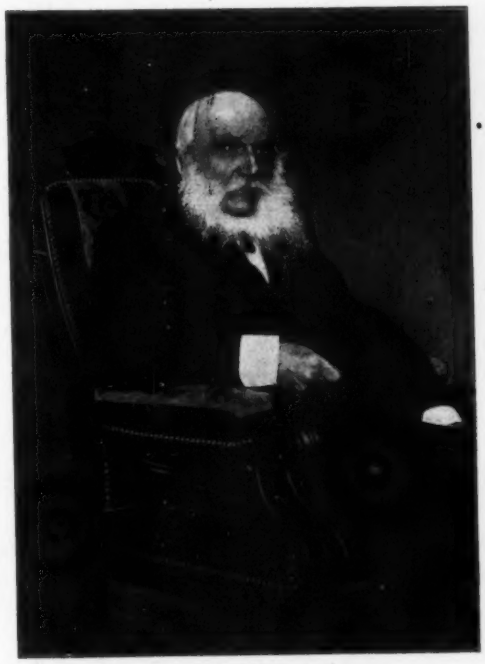
MR. E. H. MUMFORD, the well-known inventor of the Mumford moulding machine, has died in America at the age of 53 years. Early in the present year he re-established the E. H. Mumford Company at Elizabeth, N.J., after 15 years spent elsewhere in the business. Previously, he was vice-president and general manager of the Mumford Moulding Machine Company, of Chicago, the E. H. Mumford Company having acquired ownership of patents under which the Chicago company had been operating since 1909.

MR. WM. HESLOP, a well-known Leeds engineer, has died at the age of 82 years. After being for some years with Messrs. Kitson, he became manager in 1875 of the Millfield Engineering Works, Sunderland. In 1887 he joined the Leeds Forge Company, Limited, and had much to do with the development of that firm's business in pressed steel wagons and carriage frames. He then turned his attention to a patent for making seamless steel boats, and established works in Calder Vale Road, Wakefield. He retired from active participation in business about two years ago.

MR. RICHARD CLAYTON, of Coseley Hall, Coseley, died on May 16. The deceased, who was 68 years of age, as a young man practised as a solicitor in London and Wolverhampton. He, however, discarded the legal profession, and became managing director of the Cannon Iron Foundries, Limited, Deepfields. These works were established in 1826 by Messrs. Edward and Stephen Sheldon, who until 1884 traded as E. Sheldon & Company. In that year the title of the firm was changed to the Cannon Hollow-ware Company, and a few years later to its present name. Mr. Clayton had been chairman of the Black Hollow-ware Makers and Ironfounders, and took a prominent part in the formation of the Cast Hollow-ware Makers' and Ironfounders' Association, of the committee of which he was a member.

WE regret to announce the death of M. Pierre Martin, who, with Siemens, developed the Siemens-Martin process of steel manufacture. It was only at the last meeting of the Iron and Steel Institute that the Bessemer Gold Medal was conferred upon him, as recorded on page 330 of this issue.

Pierre Martin was born at Bourges, France, on August 18, 1824, and when his father, Emile Martin, purchased the Sireuil Ironworks, Charente, in 1854, he appointed his son Pierre to the management. At these works the latter experimented in steel-making, and in 1861, with the aid of his brother Emile, he developed the process of steel manufacture in the open-hearth. It was not, however, until the Siemens regenerative furnace was developed to obtain the necessary high temperature, that the Martin process was practicable on a commercial scale, but this was accomplished in 1865, when M. Martin's efforts were crowned with commercial success. Previous to that, however, other eminent metallurgists had been experimenting on similar lines, and when M. Martin came to patent his process he found the application opposed on all sides, and could not maintain the validity of his patents. The new process met with considerable success, and was adopted in a number of French works, while Martin was also awarded a gold medal for exhibits of his products at the Paris International Exhibition of 1867. But in legal actions to establish his rights to the patents, and in resisting



THE LATE M. PIERRE MARTIN.

infringements, the inventor spent all his fortune, until he was quite impoverished. Then, quite disheartened by the failure to maintain his rights, he disappeared from the metallurgical world. During his retirement the process M. Martin had invented gradually attained the success now well known.

Though the Siemens-Martin steel had attained such importance and prominence, Pierre Martin himself was practically forgotten, until he was discovered about the end of 1909 to be living in very straightened circumstances near Nevers, Central France. As soon as the fact became known, the Comité des Forges de France decided to start a fund in order to afford some reparation to the aged metallurgist, for the disappointments and hardships he had undergone, and headed the list with £4,000. In this country the initiative was taken by the Iron and Steel Institute. M. Schneider, in making the presentation referred to the great services which M. Martin had rendered to the iron and steel industry.

Parliamentary Notes.

Industry and Research.

On the vote for the expenditure incurred by the Board of Education, in the House of Commons on May 13, Mr. J. A. Pease remarked that it was essential, if we were going to maintain our position in the world, to promote a proper system of encouragement of research workers, especially in our universities. The failure hitherto had been partly due to the universities who did not realise how important it was that pure science should be associated with applied science, and brought into close contact with the manufacturing interests. It was also due partly to the fact that manufacturers themselves had undervalued the importance of science in connection with their particular industry. It was further due to the fact that the ratepayers had been too niggardly in making provision for our technical institutions and colleges. With proper organisation we should be able to succeed just in the same way as Germany had succeeded. He wanted a panel of advisers representing various industries in the country, who would be able to turn to the best account the experience they had acquired in the application of knowledge to industry. The Board of Education would work in close co-operation with the Board of Trade. Such an advisory council of distinguished men ought to be at work in the course of a few weeks. He was now considering names, and as soon as he got his committee nominated they would begin their work of advising on various matters, and as to how money could best be spent in training and research work generally, and on many specialised departments. For this purpose he should place on this year's estimates a sum of £25,000 to £30,000. They were beginning with a comparatively small sum, but they hoped it would develop. If the scheme were to succeed it must be dependent upon State aid for years to come, and it must be progressive.

Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

4,889. Apparatus for washing or sizing substances or minerals. H. J. Greaves.
4,948. Reverberatory furnaces. A. Payne, W. Smith, sen., W. Smith, jun., J. T. Smith, F. J. Smith, and S. B. Smith.
4,991. Crucible furnaces. E. Hall.
5,040. Heating-furnaces. R. F. Hislop and G. R. Hislop, jun.
5,102. Process for producing substantially pure metallic tungsten powder. J. M. Skelley.
5,103. Process for the reduction and refining of metals and the production of metallic alloys. J. M. Skelley.
5,139.*Metal-melting furnaces. I. Hall.
5,269.*Process of treating steel. Sir Charles H. A. F. L. Ross.
5,374. Moulding-machines. British Thomson-Houston Company, Limited, and W. Roxburgh.
5,677.*Hoods of forges, furnaces, etc. Soc. Ateliers Air et Feu, Jeanne Vivez (née Louvet) and J. Conor.
5,859.*Furnaces. F. H. Wolkenhauer.
5,864. Regenerative furnaces. Wellman, Seaver & Head, Limited, F. G. Smith, and A. V. Kemp.
5,871.*Furnace and method of operating same. Metallbank und Metallurgische Ges.
6,050.*Reverberatory furnaces. Manchester Furnaces, Limited. W. A. Russell, and J. Lord.
6,061. Alloy. F. La Roche.
6,062. Treatment of steel. F. La Roche.

New Companies.

Cwmavon Slag Company, Limited.—Capital £5,000 in £1 shares.

Yorkshire Basic Company, Limited.—Capital £35,000 in £1 shares. Registered office: Shireoaks, Worksop.

A.A.C. Syndicate, Limited.—Capital £11,000 in £1 shares, to carry on the business of mechanical engineers.

Ferguson, Pailin & Company, Limited.—Capital £10,000 in £1 shares, to carry on the business of engineers.

Dunston Zinc Company, Limited.—Capital £5,000 in £1 shares. Registered office: 30, Brown Street, Manchester.

George Swift & Sons, Limited.—Capital £20,000 in £10 shares, to carry on the business of mechanical engineers, etc.

Whitehaven Basic Company, Limited.—Capital £35,000 in £1 shares. Registered office: Llynclys, near Oswestry.

Union Engineering Company, Limited.—Capital £400 in £1 shares. Registered office: 8, Camden Street, Liverpool.

Taylor Engineering Company, Limited.—Capital £5,000 in £1 shares. Registered office: 19a, Thorold Road, Bowes Park, London, N.

Francis Polden & Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers. Registered office: 56, Cannon Street, E.C.

T. Jackson, Sons & Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers. Registered office: Sandford Road, Bexley Heath, Kent.

Phillips, Gilbert & Company, Limited.—Capital £2,000 in £1 shares, to carry on the business of engineers, etc. Registered office:—7, Macdonald Street, Birmingham.

A. & H. Harrison, Limited.—Capital £1,000 in £1 shares (100 founders'), to carry on the business of brassfounders. Registered office:—46½, Barker Street, Sandpits, Birmingham.

Cooper & Greig, Limited.—Capital £25,000 in £1 shares, to acquire and carry on the existing business of engineers and boiler-makers. Registered office:—Britannia Works, East Dock Street, Dundee.

William Skett, Limited.—Capital £20,000 in £1 shares, to take over the business of a brassfounder carried on by W. Skett at Temple Street, Wolverhampton. The first directors are W. Skett and I. Bryan.

Thos. H. Mirfin & Company, Limited.—Capital £2,000 in £1 shares, to take over the business carried on by T. H. Mirfin and W. H. Shephard, as Thos. H. Mirfin & Company, at the Morley Steel Works, Denby Street, Sheffield.

File and Engineering Supply Company, Limited.—Capital £2,000 in £1 shares, to take over the business carried on at Dronfield, Derbyshire, as the British File, Tool and Engineering Company. The first directors are A. J. Zursen and N. W. Dearnley.

Sam G. Mason, Limited.—Capital £5,000 in £1 shares (4,000 preference), to carry on the business of brass and ironfounders, etc. The first directors are E. C. Philp, S. G. Mason and W. Voysey.

The Tyneside Alloys, Limited.—Capital £10,000 in £1 shares, to carry on the business of extracting metals and their compounds from ores and other substances. The first directors are W. Jones, A. Y. Jones, and D. S. Jones.

T. O. Cole, Limited.—Capital £5,000 in £1 shares, to acquire the business of mechanical and general engineers, etc., heretofore carried on by T. O. Cole and Moore at Ash Road, Saltley, Birmingham. Registered offices: 47, Temple Row, Birmingham.

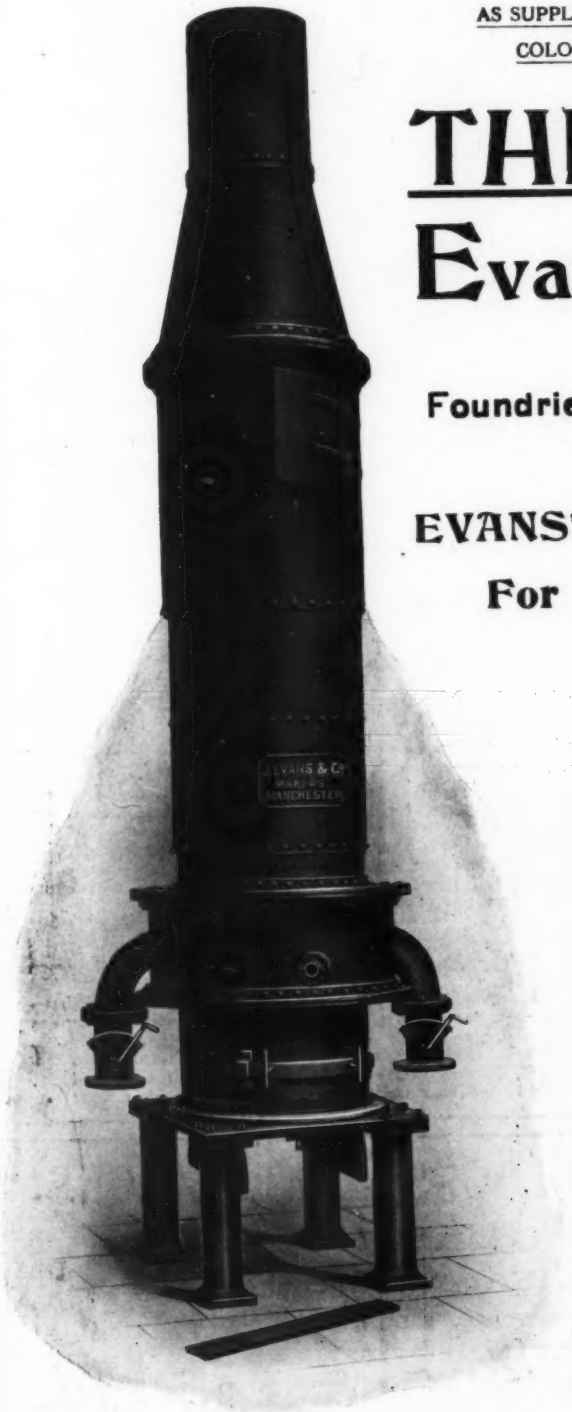
Kent Smith, Limited.—Capital £5,000 in £1 shares to carry on the business of manufacturers of and dealers in crucible steel of all kinds. The first directors are A. E. Dunstan, J. K. Smith and C. H. Hurst. Registered office: Bank Chambers, Fargate, Sheffield.

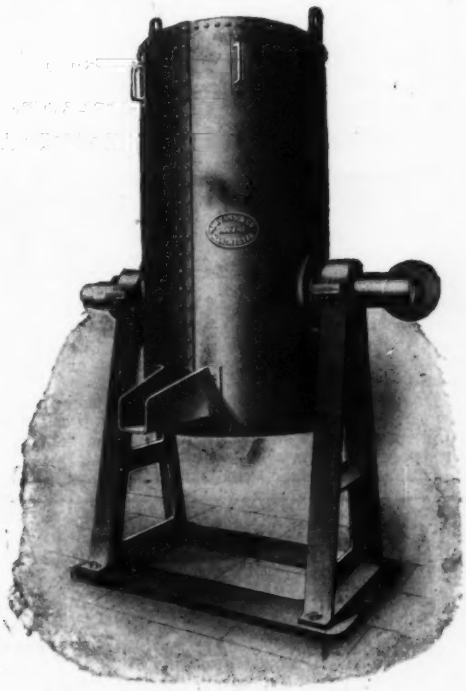
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE, COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola. Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."
Telephone: 2297 CENTRAL, MANCHESTER.

John Clarke (Birmingham), Limited.—Capital £1,000 in £1 shares, to take over the business of a brass hinge manufacturer formerly carried on by the late J. Clarke, at 61, Price Street, Birmingham, as John Clarke, and to adopt an agreement with W. J. Bloxham and T. H. Darby.

N. Downing & Sons, Limited.—Capital £10,000 in £1 shares, to take over the business of an ironfounder carried on by Mr. N. Downing at Clarence Foundry, Railway Street, Stockton-on-Tees, as N. Downing & Sons. The first directors are N. Downing, J. F. Downing, A. G. Downing and H. N. Downing.

De Bergue & Company, Limited.—Capital £30,000 in £1 shares (15,816 ordinary and 14,184 deferred), to take over the business of engineers carried on by a company of the same name at the Strangeways Ironworks, Manchester. The first directors are A. H. Jackson, Walter Leigh-Hunt, E. R. Austin, E. R. Carter, and H. Cattrall.

John Ratcliff & Sons, Limited.—Capital £20,000 in 8,000 6 per cent. preference and 12,000 ordinary shares of £1 each, to take over the business of engineers carried on by Mr. C. W. Ratcliff at Junction Foundry, Upper Wortley, Leeds, as John Ratcliff & Sons. The first directors are C. W. Ratcliff, J. D. Ratcliff, W. H. Ratcliff, and F. Ratcliff.

Anglo-Chinese Engineers' Association, Limited.—Capital £53,750 in 5,000 6 per cent. cumulative preference shares of £10 and 75,000 deferred shares of 1s. each, to carry on in China or elsewhere the business of ironfounders, mechanical engineers, etc., and to adopt agreements with A. J. Moore-Bennett. The first directors are A. J. Moore-Bennett, J. Downs (Rose, Downs & Thompson, Limited), Hull; S. Denison, H. J. Ward, 10, St. Swithin's Lane, E.C.; and W. W. Gibbs (Gwynnes, Limited), Hammersmith Iron Works, Hammersmith, W. Registered office: 9 and 10, Pancras Lane, E.C.

State Control of Workers.

A new regulation under the Defence of the Realm Act has been made by an Order in Council, published in the "Gazette." The Order sets out that—The occupier of a factory or workshop the business carried on in which consists wholly or mainly in engineering, shipbuilding, or the production of arms ammunition or explosives, or of substances required for the production thereof, shall not, nor shall any person on behalf of the occupier of such a factory or workshop, either directly or indirectly, by canvassing, advertisement or otherwise, take any steps with a view to inducing—

(*a*) Any person employed in any other factory or workshop, being a person engaged on work for any Government Department or otherwise serving war purposes, to leave his employment; or

(*b*) any person resident in the United Kingdom at a distance of more than ten miles from the occupier's factory or workshop, to accept employment therein, otherwise than by notifying vacancies to a Board of Trade Labour Exchange;

and in the event of any person contravening the provisions of this Regulation he shall be guilty of an offence against these regulations.

British Steel Smelters' Annual Report.

According to the annual report of the British Steel Smelters, Mill, Iron, Tinplate and Kindred Trades Association for the year 1914, notwithstanding unsatisfactory trade conditions, the Society gained considerable strength during the year. The removal to the new offices in Swinton Street, Grays Inn Road, W.C., was an event of considerable importance in the Society's history.

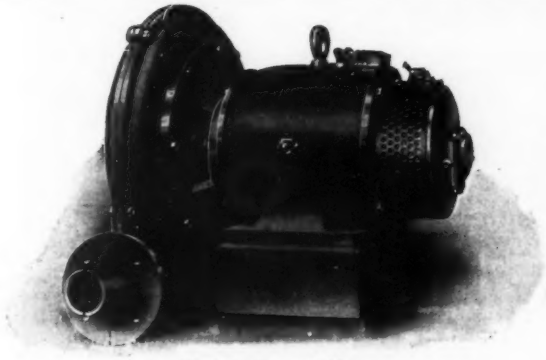
During the year £8,086 1s. 4½d. was paid in Society idle benefit to 3,644 members, as against £4,953 16s. 3d. for the year previous. On the whole, the membership has been well maintained, the decline apparently not being so heavy as might have been expected. The total membership at the end of December last was 34,142, which compares with 34,705 in 1913.

A satisfactory feature of the year, the report says, is the substantial increase in the funds of £13,375 4s. 9d., which is equal to about 7s. 9d. per member on the average membership for the year. The average weekly contribution paid by members was 5¾d. (the lowest recorded over a period of 15 years), but of this 2¼d. was returned to them in different kinds of benefit, leaving 3½d. as the net average weekly contribution.

The year 1914 has not been a particularly eventful one for the trade union movement. It is worthy of note, however, that in face of the national danger a greater spirit of toleration at once came into being, and an unwritten understanding was arrived at, that neither side should raise any new industrial question which was not of immediate importance. On the whole, the truce entered into has been well maintained.

THE partnership heretofore subsisting between Messrs. E. W. Bungeroth, H. G. Williams, W. G. Bungeroth, and C. H. Bungeroth, carrying on business as engineers, at 29, Binns Road, Liverpool, under the style of Williams, Bungeroth & Company, has been dissolved. Messrs. E. W. Bungeroth, W. G. Bungeroth, and C. H. Bungeroth will continue the business under the same style.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."



10 H.P. Fan and Motor.

TRADE SIROCCO MARK

High Pressure Fans

Are made in a large number of sizes from 10 in. diameter upwards.

Bulletins 2000 F. and 2028 F.

Some Points worth noting.

Owing to few wearing parts, the Fans are not liable to break down. The mechanical efficiency is high and remains so. The pressure is steady and the volume even and free from pulsations.

Davidson & Co., Ltd.,

Sirocco Works,
BELFAST.

ELDER'S FOUNDRY COKE

AS SUPPLIED TO THE
BRITISH
ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1901.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Celtic Collieries, Ltd., Cardiff.

Telegraph: "OUTPUT, CARDIFF." Telephone: 4640 & 4641.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining on the first day of the current month.

Pig-iron.

	June 3
Cleveland.	s. d.
Cleveland No. 1	68 0
,, No. 3	66 0
,, No. 4 foundry	65 9
,, No. 4 forge	65 0
,, Mottled	64 6
,, White	64 6
East Coast hematite, mixed Nos. ..	102 6
Cleveland warrants	65 11

Above prices are for early f.o.b. deliveries and as regards Cleveland iron are for G.M.B. brands. The warrant quotations are the sellers cash prices.

Scotland.

	s. d.
Standard Foundry (Glasgow Market settlement price)	65 4½
Warrants, ditto	71 9

Makers' prices:—	s. d.		s. d.
Gartsherrie No. 1..	85 0	No. 3..	81 0
Coltness No. 1..	102 0	No 3..	82 0
Summerlee No. 1..	85 0	No. 3..	80 0
Langloan No. 1..	85 0	No. 3..	80 0
Calder No. 1..	80 0	No. 3..	78 0
Clyde No. 1..	86 0	No. 3..	81 0
Carnbroe No. 1..	83 0	No. 3..	79 0
Monkland No. 1..	81 0	No. 3..	79 6
Shotts No. 1..	82 6	No. 3..	77 6
Govan No. 1..	75 6	No. 3..	74 6
(All deliverable alongside Glasgow.)			
Glengarnock No. 1 .	86 0	No. 3..	81 0
(Deliverable alongside Ardrossan.)			
Dalmellington No. 1	82 0	No. 3..	80 0
Eglinton No. 1..	80 0	No. 3..	79 0
(Deliverable alongside Ayr.)			
Carron No. 1..	86 0	No. 3..	81 0
(F.a.s. Grangemouth.)			

Lancashire.

	s. d.	s. d.
Lancashire No 3 foundry f.o.t.	—	—
Lincolnshire No. 3 foundry ..	75 9	76 9
Derbyshire No. 3 foundry ..	73 0	75 0
Staffordshire No. 3 foundry ..	—	72 6
Cleveland No. 3 foundry ..	—	—
(All delivered equal Manchester.)		
Scotch No. 3 — Gartsherrie	—	88 6
Glengarnock	—	87 0
Eglinton	—	87 0
Summerlee	—	87 0
(Delivered Manchester Docks.)		

North-West of England.

	s. d.	s. d.
Bessemer mixed numbers net f.o.b.	105 0	107 6
Hematite warrant net cash ..	—	95 0
Lorn cold-blast charcoal iron ..	180 0	190 0

The Midlands.

	s. d.	s. d.
Staffs. — Common forge ..	65 0	66 0
Part Mine forge ..	—	72 6
Best All Mine ..	87 6	90 0
Cold Blast	—	140 0
Strong forge, about 1s. less than grey forge; Mottled and White, about 2s. less than forge; Foundry No. 3, 3s. to 5s. above forge; No. 1 and No. 2, from 1s. 6d. to 2s. above No. 3; No. 1, about 2s. above No. 2.		
Northampton foundry	—	—
North Staffs. foundry	—	—
Derby foundry	—	—
Nottinghamshire foundry ..	—	—
Leicestershire foundry	—	78 6
Shropshire Cold-Blast	—	140 0
(Delivered South Staffordshire Works, net cash monthly.)		

Lincolnshire.

	s. d	s. d.
Forge	—	—
Grey forge..	—	—
Basic	—	—
No. 3 foundry	—	—
No. 4 foundry	—	—
F.o.t. Makers' works.		

South Wales.

	s. d.	s. d.
Welsh Hematite	107 6	110 0

Ferro-Alloys.

Net, Delivered Sheffield Steel works.

	£ s. d.
Ferro-chrome: 4/6% carbon. Basis 60%, scale 10s. per unit. Per ton	28 0 0
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	26 10 0
Ferro-chrome: 8/10% carbon. Basis 60%, scale 8s. 6d. per unit. Per ton	25 0 0
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon, broken to small pieces for use in best quality crucible steels. Basis 60%, scale 22s. per unit. Per ton	70 0 0
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy ..	0 9 0
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit .. Per ton	14 15 0
Ferro-titanium: 15/18%, per pound, flat	0 0 6½
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained	0 18 0
Ferro-phosphorus: 20/25%. Per ton	16 10 0
*Ferro-manganese 80%	20 0 0
,, export	—

* F.o.b. Liverpool.

Iron Castings.

Cleveland.

	£ s. d.	£ s. d.
Columns (plain)	7 7 6 to	7 12 6
Pipes, 1½ to 2½ in. ..	7 0 0	7 5 0
,, 3 to 4 in. ..	6 10 0	6 15 0
,, 5 to 8 in. ..	6 5 0	6 7 6
,, 10 to 16 in. ..	6 5 0	—
,, 18 to 24 in. ..	6 5 0	—
Chairs	4 7 6	4 10 0
Floor plates (open sand)	3 10 0	3 12 6
(At work).		

Non-Ferrous Metals.

Copper.	£ s. d.	£ s. d.
Standard, Cash ..	80 12 6	80 17 6
Three months ..	81 12 6	81 17 6
Electrolytic	89 10 0	90 10 0
Tough	89 10 0	90 10 0
Best selected	90 0 0	91 0 0

Tin.		
Standard, Cash ..	159 10 0	160 0 0
,, Three months	159 0 0	159 10 0
English Ingots ..	—	162 0 0
Bars	—	163 0 0
Refined	—	165 10 0

Spelter.		
American	—	100 0 0
Specials	—	—
Hard	62 0 0	
British	—	97 10 0

Lead.		
Soft foreign	—	23 0 0
English	—	24 0 0

Antimony.	
Regulus	—

Aluminium.	
Virgin Metal, 98/99% ..per ton	86 0 0

*Chromium (Metallic).	
98/99% purity per lb. ..	—

*Nickel.	
In cubes, 98/99% purity Per ton	230 0 0

*Tungsten Metal Powder.	
96/98% purity .. per lb. ..	0 6 0

*Molybdenum Metal.	
96/98% purity.. per lb. ..	—

*Cobalt Metal.	
97% purity .. per lb. ..	0 7 6

Quicksilver.	
75 lb. bottle	14 2 6

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s. d.	s. d.
Steel scrap, heavy melting ..	67 6 to	70 0
Iron scrap cast (cupola metal)	57 6	60 0

London (f.o.b.).

	£ s. d.
Heavy steel	62 6
Light ,, ...	50 0
Heavy cast	62 6

Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations: —

	A. Joseph. £ s. d.
Hy. Electrolytic Copper Scrap ..	86 0 0
Hy. Selected Scrap Brass	62 0 0
Hy. Tinned Copper Wire	75 0 0
Best Selected Gunmetal Scrap ..	72 0 0
Re-melted Ingot Lead 10s. under English Lead price on date of order.	

Stocks.

Pig-Iron in Public Store.

	June 3. Tons.	Inc. + or Dec. — since June 4. 1914. Tons.
Connal's at Glasgow Scotch	1,000	No change.
Ditto other makes ..	—	— 2
Connal's at Middlesbrough	153,153	+ 69,335
Connal's at Middlesbrough, hematite ..	—	No change.
West Coast hematite..	2,265	— 5,798

Metals.

Copper, Europe and afloat	34,090	+ 2,603
Tin, London, Holland, U.S.A. and afloat ..	16,857	— 3,182

Coke.

Middlesbrough.

	s. d.	s. d.
Gas Coke	unobtainable.	
Foundry Coke	35 0 to	40 0
Furnace coke	—	30 0

Newcastle-on-Tyne.

	F.o.b Dunston. s. d.	s. d.
FOUNDRY COKE—		
Original Garesfield ..	—	38 0
Mickley	—	38 0
Stella Garesfield ..	—	38 0
Priestman's Garesfield	—	38 0
Consett Garesfield ..	—	38 0
Newcastle gas coke ..	—	20 0

Cardiff.

	s. d.	s. d.
Special foundry coke ..	42 0 to	45 0
Foundry coke	36 0 to	40 0
Furnace coke	30 0 to	33 0

Leeds.

Furnace coke (washed) ..	23 0 to	24 0

Birmingham.

Foundry coke	—	—
Furnace ,, ...	—	—
Gas ,, ...	—	—

Glasgow.

Foundry coke	—	—
Furnace	—	—
Gas ,, ...	—	—

London.

Foundry coke ..	—	—
Gas coke (Beckton) into barge	—	—
,, into wagon at Works	—	—
Gas coke, Provincial (London sidings)	—	—

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

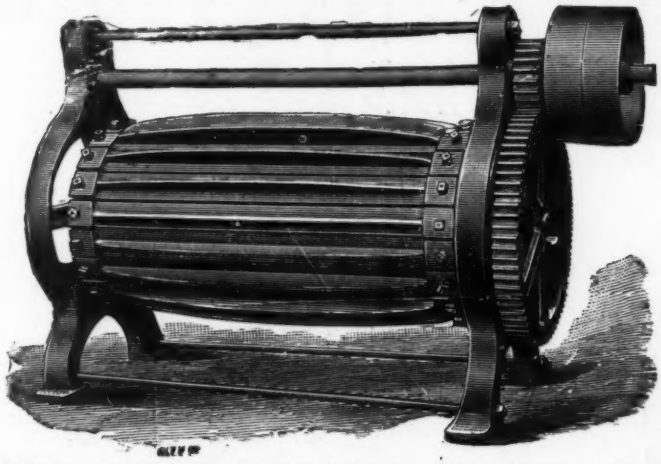
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

ANALYSES
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Consulting Metallurgists and Analytical Chemists.

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PLUMBAGO — CRUCIBLES.

Parting Powder.

William OLSEN

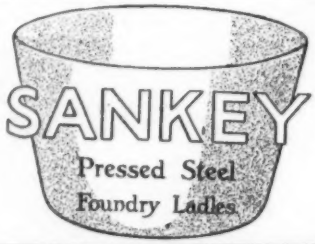
CORE ROPINGS

STRAW AND WOOD, all sizes, quick Delivery.

COCAN STREET, **HULL.**

Wax Core Vent.

GLUTRIN — CORE GUM.



SANKEY
SEAMLESS PRESSED STEEL
FOUNDRY LADLES
Plain or Lipped: Made in any capacity from ½ cwt. to 4 cwts. Write for Details.

JOSEPH SANKEY & SONS LTD., HADLEY, SALOP.

PATTERN SHOP SUPPLIES.

Wires: "Requisites, B'ham." **J. BURN & CO.,** Phone: 137 Victoria.

HENSHAW ROAD, SMALL HEATH. **BIRMINGHAM.**

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EVERY DESCRIPTION OF **MOULDERS'**
PATENT WOOD, MINERAL and **COAL DUST BLACKINGS**
MANUFACTURED.

Wheathill Charcoal Works, **SALFORD.**

THE "PORTWAY"
PORTABLE CORE OVENS
For Gas or Fuel.

TESTIMONIAL.

From The Braintree Castings Co., Chapel Hill Foundries, Braintree, Essex.

Gentlemen,

We are very pleased with the Core Oven we recently purchased from you. We find it dries the cores quickly without burning them. It is very handy and economical to use and is altogether superior to other ovens of this type we have in use.

Will you please quote us your best price for four more like it.

Yours faithfully,
For The Braintree Castings Co.,
(Signed) W. B. LAKE, Director

Makers: **C. PORTWAY & SON,** TORTOISE STOVE & PORTWAY PORTABLE OVEN WORKS, **HALSTEAD, ESSEX.**

SITUATIONS VACANT AND WANTED.

REPRESENTATIVE wanted for Scotland on commission, by Foundry Trade Specialists.—Give full particulars and ground covered to G., Box 570, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

MOULDER, used to general, light, and medium Castings, desires responsible position or favourable change. Has some technical knowledge, acquainted with plate and machine Age 33, married, temperate.—Apply Box No. 568, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOREMAN Wanted for Ironfoundry in Scotland. Must be well up in modern Foundry work and control of men.—Apply, stating experience and salary required, to Box 566, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

IRON FOUNDRY MANAGER (age 29 years) desires change; can take entire charge of works; quoting prices and getting out costs done systematically; would travel and break new ground.—Apply Box 572, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

WANTED, Energetic Works Manager for foundry in London district; steady employment and advancement for suitable man. State salary required and previous experience.—Box 574, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED.

TO BRASS FOUNDERS AND OTHERS.—For SALE, almost new HAND MOULDING MACHINE, SAND MILL, ROTARY SIEVE, First Class GAS ENGINE, LATHES, and other Machines.—Apply Box 490, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

ONE nearly new No. 2 Roots' Blower, by Alldays & Onions, driven both ends, 12 in. pulleys, 8 in. outlet, gearing in new condition; very cheap.—Marple & Gillott, Limited, Sheffield.

BLOWERS.—Three 2-in. Keith Blackman's, and one engine-driven, 7 in. by Roots; 36 in. Fan, 14 in. outlet, and 6 in. Dempster Gas Exhauster.—Address, Box 575, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

A 5-TON Hand Foundry Jib Crane, 17 ft. radius, 20 ft. high, double-geared crab chains and return blocks, racking in and out motions, with top fixing and foot step; very low price to clear.—C. F. Davis, 18, Billiter Buildings, London, E.C.

ENGINEER'S BUSINESS FOR SALE, sound investment, well up general repairs, and gas engines speciality; established 16 years; plant and goodwill £250.—91, Riversdale Road, Highbury, London, N.

FRODAIR

SPECIAL PIG IRON

for

CYLINDERS, CHILLED CASTINGS,
MACHINE CASTINGS, and any
:: :: FOUNDRY PURPOSE. :: ::

ASK FOR OUR SUGGESTIONS FOR ECONOMICAL IRON MIXTURES.

THE FRODAIR IRON & STEEL CO., LTD.,

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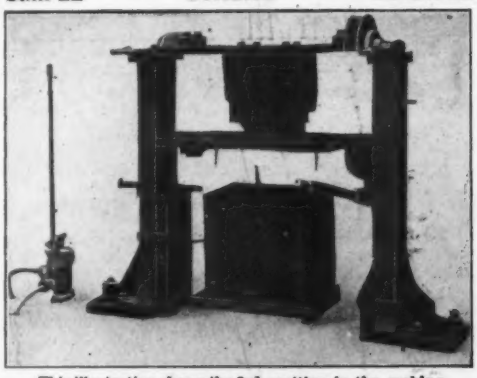
THE "CHIPCHASE" PATENT

MOULDING MACHINE.

(HYDRAULIC or PNEUMATIC)

SIMPLE - STRONG - DURABLE



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THE "CHIPCHASE" PATENT JARRING MACHINE.

THE "CHIPCHASE" PATENT CORE MAKING MACHINE.

Sole Makers—

DAVID BRIDGE & Co., Ltd.,

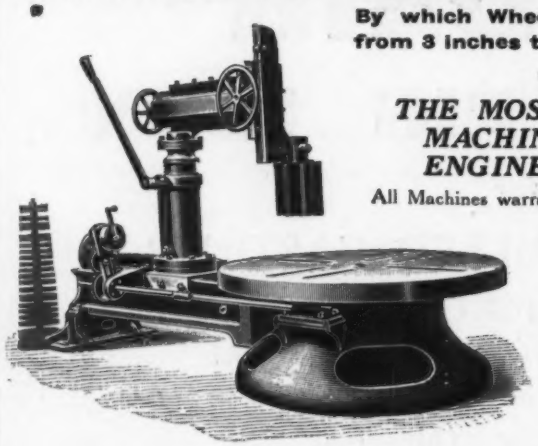
CASTLETON FOUNDRY, CASTLETON, MANCHESTER.

38¼"
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL.
KINNING PARK IRONWORKS,
GLASGOW.
38"
32½"

Can also be made in Aluminium.

WHITTAKER'S IMPROVED MOULDING MACHINE

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made.



THE MOST COMPLETE AND EFFICIENT MACHINE HITHERTO INTRODUCED TO ENGINEERS.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

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